OPERATING INSTRUCTIONS

# FLOWSIC600

Ultrasonic Gas Flow Meter
for Custody Transfer and
Process Applications

*II*+

SICK | MAIHAK
Analyzers and Process Instrumentation

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# About this Document

This manual describes the FLOWSIC600 measuring system, which is used to determine the volumetric flow rate, volume and the velocity of sound in gases transported in pipelines. It provides general information on the measuring method employed, design and function of the entire system and its components, and on planning, assembly, installation, commissioning, maintenance and troubleshooting. Contrasting the characteristic properties of available system variants aims to facilitate a decision already in the planning phase on a configuration that is ideally suited to the measuring task.

This manual covers standard applications which are conform with the technical data specified. Additional information and assistance for special applications are available from your SICK MAIHAK representative. However, it is generally recommended to take advantage of qualified consulting services provided by SICK MAIHAK experts for your specific application.

This operating manual is a part of the FLOWSIC600 device documentation. That documentation includes the following documents:

- MEPAFLOW600 software manual,

Option, for trained staff only:

- FLOWSIC600 service manual,
- FLOWSIC600 extraction tool operating instructions

### Symbols used in this document

Important information, in particular safety instructions, are highlighted in this document to facilitate quick access. Such information is provided where necessary within each section of this manual.

**Note** Provides information about special features of the equipment and further recommendations.

TYPE APPROVAL

Indicates a section with data which possibly deviate from the respective national type approval. Therefore read the appropriate approval papers when using the FLOWSIC600 for custody transfer application.

ATTENTION

**Important**

Indicates potential risks for the equipment and possible functional impairment.

DANGER

**Warning**

Indicates potential hazards for the operating staff, in particular caused by electrical installations and improper use of the equipment. Always observe such warnings, as they aim to protect you from serious injuries.

**Note** Always read this manual carefully before carrying out any work on the equipment. Always observe warnings and comply with all safety instructions.

Any obligations of SICK MAIHAK are set forth in the relevant purchase agreement. This agreement also includes the complete and solely valid warranty conditions.


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**Abbreviations used in this manual**

| | |
|---|---|
| ASCII | **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange |
| ANSI | **A**merican **N**ational **S**tandards **I**nstitute |
| ASME | **A**merican **S**ociety of **M**echanical **E**ngineers |
| CSA | **C**anadian **S**tandards **A**ssociation |
| DC | **D**irect **C**urrent |
| DIN | **D**eutsches **I**nstitut für **N**ormung (German Standards Institute) |
| DN | **N**ominal **D**iameter (internal) |
| DSP | **D**igital **S**ignal **P**rocessor |
| EC | **E**uropean **C**ommunity |
| EN | **E**uro **N**orm (European Standard) |
| Ex | Potentially **ex**plosive atmosphere (hazardous area) |
| HART | Communication interface |
| act. | actual (under operating conditions) |
| IEC | **I**nternational **E**lectrotechnical **C**ommission |
| norm. | normalised (under standard conditions) |
| LED | **L**ight **E**mitting **D**iode |
| MEPAFLOW | **Me**nu-assisted **Pa**rameterisation and Diagnosis for **FLOW**SIC600 |
| MDR | **M**anufacturer **D**atal **R**eport |
| NAMUR | **N**ormen**a**rbeitsgemeinschaft für **M**ess- **u**nd **R**egeltechnik in der chemischen Industrie (now "Interessengemeinschaft Prozessleittechnik der chemischen und pharmazeutischen Industrie"; ~ Association for Instrumentation and Control Standards in the Chemical Industry) |
| OIML | **O**rganisation **I**nternationale de **M**etrologie **L**egale |
| PC | **P**ersonal **C**omputer |
| PTB | **P**hysikalisch **T**echnische **B**undesanstalt (~ Federal Metrology Office in Germany) |
| RTU | **R**emote **T**erminal **U**nit |
| SPU | **S**ignal **P**rocessing **U**nit |
| VDE | **V**erband **d**er **E**lektrotechnik Elektronik Informationstechnik (~ Association of German Electrical Engineers) |


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# 1 Safety Instructions

## 1.1 Intended Use of the Equipment

The FLOWSIC600 measuring system is used for measuring the actual volumetric flow rate of gases transported in pipelines. The FLOWSIC600 measuring system can further be used for measuring the actual volume and velocity of sound in gases.

The measuring system shall only be used as specified by the manufacturer and as set forth below. Always observe the following information:

- Make sure the use of the equipment complies with the technical data, information about the permitted use, assembly and installation specifications and ambient and operating conditions. Any relevant information is provided in the order documentation, type plate, certification documents and this manual.
- Any actions aiming at maintaining the value of the equipment, e.g. service and inspection, transport and storage etc., shall be performed as specified.
- Do not expose the equipment to mechanical stress, such as pig cleaning.

## 1.2 Authorised Staff

Persons responsible for safety issues shall ensure the following:

- Any work on the measuring system shall only be carried out by qualified persons and must be approved by responsible skilled persons.
  Due to their professional training, knowledge and vocational experience, as well as their knowledge of the relevant standards, regulations, health and safety regulations and equipment conditions, qualified persons shall be assigned by the person responsible for personal and plant safety to carry out such work. Qualified persons must be able to identify possible dangers and to take preventive action in due time.
  Skilled persons are defined in DIN VDE 0105 and IEC 364, or comparable standards.
- Skilled persons shall have precise knowledge of process-specific dangers, e.g. due to the effects of hot, toxic and pressurised gases, gas-liquid mixtures and other process media, and of the design and working principle of the measuring system and shall have received and be able to document appropriate training.
- In hazardous areas, wiring and installation shall only be carried out by staff trained according to EN 60079-14 and according to national regulations.

## 1.3 General Safety Instructions and Protective Measures

Using the equipment for any other purpose than intended, and improper operation may result in injuries and damage to the equipment. Read this section and the notes and warnings in the individual sections of this manual carefully and observe the instructions given therein when carrying out any work on the FLOWSIC600 measuring system.

Generally:

- Always comply with the statutory provisions and the associated technical rules and regulations relevant for the present equipment when preparing and carrying out any work on the measuring system. Pay particular attention to potentially hazardous parts of the equipment, such as pressure pipes and explosion protection zones. Always observe the relevant regulations.
- Always consider local and equipment-specific conditions and process-specific dangers when carrying out any work on the equipment.


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- Operating and service instructions and equipment documentation shall always be available on site. Always observe the safety instructions and notes on the prevention of injuries and damage given in these manuals.
- Make sure appropriate protective accessories are available in sufficient supply. Always use such protective accessories. Check that appropriate safety devices are fitted and working correctly.

### 1.3.1 Dangers due to hot, corrosive and explosive gases and high pressure

The FLOWSIC600 measuring system is directly integrated into gas-carrying pipelines.

The operating company shall be responsible for safe operation and for complying with additional national and company-specific regulations.

DANGER

**Warning**

In plants with toxic and explosive gases, high pressure or high temperatures, the FLOWSIC600 measuring system shall only be mounted and dismounted if the pipelines are vented or if the plant is not working.

The same applies to repair and service work which involves opening measuring channel or the explosion-proof signal processing unit (SPU).

**Note** Design, manufacture and inspection of the FLOWSIC600 measuring system are performed in compliance with the safety requirements set forth in the European Pressure Equipment Directive 97/23/EC. Any relevant information has been taken into account for the particular application as specified in the technical information questionnaire filled out by the customer before commencing order processing.

### 1.3.2 Dangers due to heavy loads

The FLOWSIC600 measuring system must be safely attached to the carrying structure when being transported and installed.

DANGER

**Warning**

- Only use lifting gear and auxiliaries (e.g. lifting straps) which is suitable for the weight to be lifted. Max. load information can be found on the type plate of the lifting gear.
- The eye bolts attached to the equipment are suitable for the transport of the measuring device. However, additional loads (e.g. blind covers, filling for pressure tests) must not be lifted and transported together with the measuring system.
- Never attach lifting gear to the signal processing unit or its mounting bracket and avoid contact between these parts and the lifting gear.

### 1.3.3 Environmental information and instructions for disposal

The FLOWSIC600 modules are easily disassembled and do not contain toxic, radioactive or any other enviromentally hazardous materials. Mainly the instrument consists of steel, stainless steel, plastic and aluminium, and consequently there are no difficulties for disposal. Only the printed-circuit boards must be disposed of as electronic scrap.


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# FLOWSIC600

# Ultrasonic Gas Flow Meter

## Product Description


Features and Applications

Conformity, Configuration, Technical Data

System Components

Measuring Principle

Operating States and Signal Output

Self-diagnosis

Event Logging

Path Failure Compensation

Configuration

# 2 Product Description

## 2.1 Features and Applications

### System features

The FLOWSIC600 measuring system is the first compact gas meter used for ultrasonic volumetric gas flow measurements. The measuring system is characterised by the following features:

- Specially designed compatible modules
- Ultrasonic transducers integrated into the meter body
- Concealed cabling

As a result, this measuring system is extremely robust and provides maximum accuracy, even under extremely rough operating conditions. Its compact design also provides protection from mechanical damage, thereby ensuring a long-term stable measurement that is insensitive to mechanical or electrical interference.

Fig. 2.1: FLOWSIC600

### Applications

The FLOWSIC600 is ideally suited for a wide range of applications in custody transfer or process measurements, such as

- Production, transportation and distribution of natural gas
- Company-internal metering and billing
- Power stations and other gas-consuming installations
- Chemical and petrochemical industries
- Compressed air distribution systems.


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## 2.2 Conformity, Configuration, Technical Data

### 2.2.1 CE certificate

The FLOWSIC600 has been developed, manufactured and tested in accordance with the following EC directives:

- Pressure Equipment Directive 97/23/EC
- Directive 94/9/EC (ATEX100)
- EMC Directive 89/336/EC

Conformity with above directives has been verified and the equipment given the CE label.

### 2.2.2 Standard compatibility and type approval

The FLOWSIC600 was developed, designed and certified according to the following recommendations:

- OIML R 6, 1989, "General provisions for gas volume meters"
- OIML D 11, 2004, "General requirements for electronic measuring instruments"
- A.G.A Report No. 9, 1998, "Measurement of Gas by Multipath Ultrasonic Meters"
- OIML R 32, 1989, "Rotary piston gas meters and turbine gas meters", Annex A

Type approval for commercial or custody transfer was granted by the relevant authorities, e.g.:

Germany:
PTB (Physikalisch-Technische Bundesanstalt), code number 7.421 / 03.05;

Netherlands:
NMI (Netherlands Meetinstituut), code number B35


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### 2.2.3 Key code (indicated on type plate)

| Group | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Key code** | FL600- | | | | | | | | - | - | | | | | |
| 1 | **METER BODY** | | | | | | | | | | | | | | | |
| | **Path configuration** | | | | | | | | | | | | | | | |
| | 1-Path | 1 P | | | | | | | | | | | | | | |
| | 2-Path | 2 P | | | | | | | | | | | | | | |
| | 4-Path | 4 P | | | | | | | | | | | | | | |
| | 1-Path redundant | 1 R | | | | | | | | | | | | | | |
| | 2-Path redundant | 2 R | | | | | | | | | | | | | | |
| | 4-Path redundant | 4 R | | | | | | | | | | | | | | |
| | 4+1 Check meter | 5 C | | | | | | | | | | | | | | |
| | 2-Path crossed | 2 X | | | | | | | | | | | | | | |
| | 4-Path crossed | 4 X | | | | | | | | | | | | | | |
| 2 | **Overall length** | | | | | | | | | | | | | | | |
| | 3D (standard length) | | 3 D | | | | | | | | | | | | | |
| | 5D | | 5 D | | | | | | | | | | | | | |
| | Other size | | X D | | | | | | | | | | | | | |
| 3 | **Nominal size** | | | | | | | | | | | | | | | |
| | 2" / DN 50 | | | 0 2 | | | | | | | | | | | | |
| | 3" / DN 80 | | | 0 3 | | | | | | | | | | | | |
| | 4" / DN 100 | | | 0 4 | | | | | | | | | | | | |
| | 6" / DN 150 | | | 0 6 | | | | | | | | | | | | |
| | 8" / DN 200 | | | 0 8 | | | | | | | | | | | | |
| | 10" / DN 250 | | | 1 0 | | | | | | | | | | | | |
| | 12" / DN 300 | | | 1 2 | | | | | | | | | | | | |
| | 16" / DN 400 | | | 1 6 | | | | | | | | | | | | |
| | Other size | | | X X | | | | | | | | | | | | |
| 4 | **Connection flange type** | | | | | | | | | | | | | | | |
| | ANSI CLASS 150 | | | | C L 0 1 5 0 | | | | | | | | | | | |
| | ANSI CLASS 300 | | | | C L 0 3 0 0 | | | | | | | | | | | |
| | ANSI CLASS 600 | | | | C L 0 6 0 0 | | | | | | | | | | | |
| | ANSI CLASS ??? | | | | C L X X X X | | | | | | | | | | | |
| | DIN/ISO PN16 | | | | P N 0 0 1 6 | | | | | | | | | | | |
| | DIN/ISO PN 64 | | | | P N 0 0 6 4 | | | | | | | | | | | |
| | DIN/ISO PN 100 | | | | P N 0 1 0 0 | | | | | | | | | | | |
| | DIN/ISO PN ??? | | | | P N X X X X | | | | | | | | | | | |
| 5 | **Inner diameter** | | | | | | | | | | | | | | | |
| | Schedule 40 (ANSI) | | | | | S C 0 0 4 0 | | | | | | | | | | |
| | Schedule 80 (ANSI) | | | | | S C 0 0 8 0 | | | | | | | | | | |
| | Schedule ??? (ANSI) | | | | | S C X X X X | | | | | | | | | | |
| | Specified in [mm] (DIN) | | | | | X X X . X X | | | | | | | | | | |
| 6 | **Flange type / sealing face** | | | | | | | | | | | | | | | |
| | Raised Face (ANSI B16.5) | | | | | | R F | | | | | | | | | |
| | Ring Type Joint (ANSI B16.5) | | | | | | R J | | | | | | | | | |
| | Glatt Form C (DIN 2526) | | | | | | G C | | | | | | | | | |
| | Glatt Form E (DIN 2526) | | | | | | G E | | | | | | | | | |
| | Form B1 (EN 1092-1) | | | | | | B 1 | | | | | | | | | |
| | Form B2 (EN 1092-1) | | | | | | B 2 | | | | | | | | | |
| | Special design | | | | | | X X | | | | | | | | | |
| 7 | **Material** | | | | | | | | | | | | | | | |
| | Carbon Steel (1.1120) | | | | | | | 0 | | | | | | | | |
| | Stainless steel (1.4408) | | | | | | | 1 | | | | | | | | |
| | LT-CS (1.6220) | | | | | | | 2 | | | | | | | | |
| | Duplex (1.4470) | | | | | | | 3 | | | | | | | | |
| 8 | **Connection for Extraction Tool** | | | | | | | | | | | | | | | |
| | Yes | | | | | | | | Y | | | | | | | |
| | No | | | | | | | | N | | | | | | | |
| 9 | **ULTRASONIC TRANSDUCER** (Will be selected by SICK MAIHAK on the basis of the technical data ) | | | | | | | | | _ _ | | | | | | |
| 10 | **SIGNAL PROCESSING UNIT** | | | | | | | | | | | | | | | |
| | **Ex-proof-design** | | | | | | | | | | | | | | | |
| | CSA Group D T4 | | | | | | | | | | 1 | | | | | |
| | CSA Group B, C, D T4 | | | | | | | | | | 2 | | | | | |
| | ATEX IIA T4, M20x15 | | | | | | | | | | 3 | | | | | |
| | ATEX IIC T4, M20x1.5 | | | | | | | | | | 4 | | | | | |
| | ATEX IIA T4, 1/2 NPT | | | | | | | | | | 5 | | | | | |
| | ATEX IIC T4, 1/2 NPT | | | | | | | | | | 6 | | | | | |
| 11 | **Power supply** | | | | | | | | | | | | | | | |
| | 12 ... 24V DC | | | | | | | | | | | D C | | | | |
| 12 | **Data outputs** | | | | | | | | | | | | | | | |
| | Hardware variant 1 (4 digital outputs) | | | | | | | | | | | | 1 | | | |
| | Hardware variant 2 (1 analog current output and 3 digital outputs) | | | | | | | | | | | | 2 | | | |
| | Hardware variant 3 (with integrated volume corrector) | | | | | | | | | | | | 3 | | | |
| | Hardware variant 4 (1 analog current output and 2 RS485) | | | | | | | | | | | | 4 | | | |
| 13 | **HART-Protocol** (By selection of hardware variant 2 only) | | | | | | | | | | | | | | | |
| | Yes | | | | | | | | | | | | | Y | | |
| | No | | | | | | | | | | | | | N | | |
| 14 | **Front panel** | | | | | | | | | | | | | | | |
| | LED SICK/MAIHAK | | | | | | | | | | | | | | 0 | |
| | LCD SICK/MAIHAK | | | | | | | | | | | | | | 1 | |
| 15 | **Custody Transfer design** | | | | | | | | | | | | | | | |
| | Yes | | | | | | | | | | | | | | | Y |
| | No | | | | | | | | | | | | | | | N |

Fig. 2.2: Common key code used for short description of meter design


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### 2.2.4 Technical data

TYPE APPROVAL

**Common meter sizes and flow rates**

| | | Flow rate a.c. in $m^3/h$ | | Flow rate in $ft^3/h$ | | Max. Velocity in | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | $m^3/h$ | $ft^3/h$ |
| DN 50 | (NPS 2) | 6 | 400 | 210 | 14.000 | 65 | 213 |
| DN 80 | (NPS 3) | 12 | 1.000 | 280 | 35.000 | 65 | 213 |
| DN 100 | (NPS 4) | 20 | 1.600 | 460 | 57.000 | 60 | 197 |
| DN 150 | (NPS 6) | 32 | 3.000 | 1.130 | 106.000 | 50 | 164 |
| DN 200 | (NPS 8) | 40 | 4.500 | 1.410 | 159.000 | 45 | 148 |
| DN 250 | (NPS 10) | 50 | 7.000 | 1.770 | 247.000 | 40 | 131 |
| DN 300 | (NPS 12) | 65 | 8.000 | 2.300 | 283.000 | 33 | 108 |
| DN 350 | (NPS 14) | 80 | 10.000 | 2.830 | 353.000 | 33 | 108 |
| DN 400 | (NPS 16) | 120 | 14.000 | 4.240 | 494.000 | 33 | 108 |
| DN 450 | (NPS 18) | 130 | 17.000 | 4.590 | 600.000 | 33 | 108 |
| DN 500 | (NPS 20) | 200 | 20.000 | 7.060 | 706.000 | 33 | 108 |
| DN 600 | (NPS 24) | 320 | 32.000 | 11.300 | 1.130.000 | 33 | 108 |
| DN 700 | (NPS 28) | 650 | 40.000 | 22.950 | 1.413.000 | 30 | 99 |
| DN 750 | (NPS 30) | 650 | 45.000 | 22.950 | 1.589.000 | 30 | 99 |
| DN 800 | (NPS 32) | 800 | 50.000 | 28.250 | 1.766.000 | 30 | 99 |
| DN 900 | (NPS 36) | 1000 | 66.000 | 35.320 | 2.331.000 | 30 | 99 |
| DN 1000 | (NPS 40) | 1200 | 80.000 | 42.380 | 2.825.000 | 30 | 99 |
| DN 1050 | (NPS 42) | 1300 | 85.000 | 45.910 | 3.002.000 | 30 | 99 |
| DN 1100 | (NPS 44) | 1400 | 90.000 | 49.440 | 3.178.000 | 28 | 92 |
| DN 1200 | (NPS 48) | 1600 | 100.000 | 56.500 | 3.531.000 | 27 | 89 |


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### Other information

| | |
|---|---|
| Meter size up to DN600/ 24" | Body with flanges in carbon steel 1.1120/ ASME A216 WCC<br>Body with flanges in stainless steel 1.4408/ ASME A351 Gr. CF 8M |
| Meter size > DN600/ 24" | Body in carbon steel 1.1120/ ASME A216 WCC, flanges ASTM105<br>Body in stainless steel 1.4408/ ASME A351 Gr. CF 8M, flanges in 1.4404/ A182 Gr. F316L |
| **Common data** | |
| Number of measuring paths | 1, 2 or 4 |
| Min. gas velocity | 0.3 m/s; 1 ft/s |
| Turn down ($v_{min}/v_{max}$) | Max. 1 : 130 |
| **Measuring medium** | |
| Gases | Natural gas, process gases, air, Ethylene, etc. |
| Pressure range | 0 barg ... 250 barg (0 psig ... 3600 psig); up to 450 barg (6500 psig) on request |
| Temperature range | -30 °C ... + 180 °C (-22 °F ... 365 °F); -194 °C ... 280 °C (-317 °F ... 536 °F) on request |
| **Measuring uncertainty** | |
| Repeatibility | < 0.1 % of reading |
| Typical uncertainty * | 1 path ± 2.0 %<br>2 paths ± 1.0 %<br>4 paths ± 0.5 %; ± 0.2 % after high pressure calibration |
| **Power supply** | |
| Operating voltage | 12 ... 28.8 V DC (minimum 15 V DC for active current output) |
| Typ. power consumption | < 1 W |
| **Outputs** | |
| Measuring variables | Flow rate a.c., volume a.c., gas velocity, speed of sound |
| Analog output | 4 .. 20 mA; active / passive; electrically isolated; max load = 250 Ω |
| Pulse and status outputs | Passive, electrically isolated, open collector or acc. NAMUR, $f_{max}$ = 6 kHz (scalable),<br>pulse width = 0,05 .. 1 s in accordance with NAMUR (EN50227) |
| **Interfaces** | |
| MODBUS ASCII and RTU | 2 x RS485 for configuration, measured value output and diagnosis |
| HART® | Configuration, measured value output and diagnosis |
| **Ex approval** | |
| Europe (ATEX 94/9/EG) | II 1/2G EEx de ib [ia] IIA T4 or II 1/2G EEx de ib [ia] IIC T4<br>Ultrasonic transducers intrinsically safe "ia" |
| USA / Canada (CSA) | Class I, Division 1, Groups D T4; Class I, Division 2, Groups D T4<br>Class I, Division 1, Groups B,C, D T4; Class I, Division 2, Groups A, B, C, D T4<br>Ultrasonic transducers intrinsically safe "ia"** |
| **Ambient conditions** | |
| Temperature range (ATEX) | -40 °C ... +60 °C (-40 °F .. 140 °F) |
| Storage temperature | -40 °C ... +60 °C (-40 °F .. 140 °F) |
| IP classification | IP 67 |
| Relative humidity | < 95 % |

* Within $Q_t$ .. $Q_{max}$ and with straight inlet/outlet section of 10 D/3 D or 5 D/3 D with flow straightener

** Approval for operation the ultrasonic transducers within zone 0 only valid under atmospheric conditions (-20 °C ≤ $T_{medium}$ ≤ +60 °C; 0.8 bara ≤ $p_{medium}$ ≤ 1.1 bara)

ATTENTION

**Warning**

When used in hazardous areas, comply with the required type of explosion protection during installation (intrinsically safe or increased safety)!


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**Remarks in case the meter is used according to PTB (German) rules**

- Any flow rates given above are also valid in the bidirectional mode.
- Meter sizes marked with an asterisk (*) must only be used in configuration no. 2 (see Section *3.2*).
- Meters sizes marked with an (E) have an extended max. flow rate (max. flow velocity $v_{max}$ = 36 m/s) related to commonly established turbine meter G-classes
- The transition flow $Q_t$ results from the flow range the meter is designed for according to the main plate. It is

  for a flow range of 1:20 $Q_t = 0.20\ Q_{max}$ and
  for a flow range of 1:30 $Q_t = 0.15\ Q_{max}$ and
  for a flow range of $\geq$ 1:50 $Q_t = 0.10\ Q_{max}$

**Example Meter sizes and measuring range for custody transfer applications according to PTB**

| | **Min. flow rate $Q_{min}$ [m³/h]** | **Meter size** | **Max. flow rate $Q_{max}$ [m³/h]** | **Measuring range** | **Pulse value [pulses/m³]** |
|---|---|---|---|---|---|
| DN 80 (NPS 3) | 13 | G160 | 250 | 1:20 | 28800 |
| | 13 / 20 | G250 | 400 | 1:30 / 1:20 | 18000 |
| | 13 / 20 / 32 | G400 * | 650 | 1:50 / 1:30 / 1:20 | 11100 |
| DN 100 (NPS 4) | 20 | G250 | 400 | 1:20 | 18000 |
| | 20 / 32 | G400 | 650 | 1:30 / 1:20 | 11100 |
| | 20 / 32 / 50 | G650 * | 1000 | 1:50 / 1:30 / 1:20 | 7200 |
| DN 150 (NPS 6) | 32 | G400 | 650 | 1:20 | 11100 |
| | 32 / 50 | G650 | 1000 | 1:30 / 1:20 | 7200 |
| | 32 / 50 / 80 | G1000 | 1600 | 1:50 / 1:30 / 1:20 | 4500 |
| | 32 | G1000 E | 2200 | 1:70 | 3272 |
| | 32 / 50 / 80 / 130 | G1600 * | 2500 | 1:80 / 1:50 / 1:30 / 1:20 | 2880 |
| DN 200 (NPS 8) | 50 | G650 | 1000 | 1:20 | 7200 |
| | 50 / 80 | G1000 | 1600 | 1:30 / 1:20 | 4500 |
| | 50 / 80 / 130 | G1600 | 2500 | 1:50 / 1:30 / 1:20 | 2880 |
| | 40 | G1600 E | 3600 | 1:80 | 2000 |
| | 40 / 80 / 130 / 200 | G2500 * | 4000 | 1:100 / 1:50 / 1:30 / 1:20 | 1800 |
| DN 250 (NPS 10) | 50 / 80 | G1000 | 1600 | 1:30 / 1:20 | 4500 |
| | 50 / 80 / 130 | G1600 | 2500 | 1:50 / 1:30 / 1:20 | 2880 |
| | 50 / 80 / 130 / 200 | G2500 | 4000 | 1:80 / 1:50 / 1:30 / 1:20 | 1800 |
| | 50 | G2500 E | 5600 | 1:100 | 1285 |
| | 50 / 130 / 200 /320 | G4000 * | 6500 | 1:130 / 1:50 / 1:30 / 1:20 | 1110 |
| DN 300 (NPS 12) | 80 / 130 | G1600 | 2500 | 1:30 / 1:20 | 2880 |
| | 80 / 130 / 200 | G2500 | 4000 | 1:50 / 1:30 / 1:20 | 1800 |
| | 65 / 130 / 200 / 320 | G4000 | 6500 | 1:100 / 1:50 / 1:30 / 1:20 | 1110 |
| | 65 | G4000 E | 7800 | 1:120 | 920 |
| DN 350 (NPS 14) | 80 | G1600 | 2500 | 1:30 | 2880 |
| | 80 / 130 / 200 | G2500 | 4000 | 1:50 / 1:30 / 1:20 | 1800 |
| | 80 / 130 / 200 / 320 | G4000 | 6500 | 1:80 / 1:50 / 1:30 / 1:20 | 1110 |
| | 80 | G4000 E | 7800 | 1:100 | 920 |
| DN 400 (NPS 16) | 130 / 200 | G2500 | 4000 | 1:30 / 1:20 | 1800 |
| | 130 / 200 / 320 | G4000 | 6500 | 1:50 / 1:30 / 1:20 | 1110 |
| | 120 / 200 / 320 / 500 | G6500 | 10000 | 1:80 / 1:50 / 1:30 / 1:20 | 720 |
| | 120 | G6500 E | 12000 | 1:100 | 600 |
| DN 450 (NPS 18) | 130 | G2500 | 4000 | 1:30 | 1800 |
| | 130 / 200 / 320 | G4000 | 6500 | 1:50 / 1:30 / 1:20 | 1110 |
| | 130 / 200 / 320 / 500 | G6500 | 10000 | 1:80 / 1:50 / 1:30 / 1:20 | 720 |
| | 120 | G6500 E | 12000 | 1:100 | 600 |
| DN 500 (NPS 20) | 200 / 320 | G4000 | 6500 | 1:30 / 1:20 | 1110 |
| | 200 / 320 / 500 | G6500 | 10000 | 1:50 / 1:30 / 1:20 | 720 |
| | 200 / 320 / 500 / 800 | G10000 | 16000 | 1:80 / 1:50 / 1:30 / 1:20 | 450 |
| | 200 | G10000 E | 20000 | 1:100 | 360 |
| DN 600 (NPS 24) | 320 / 500 | G6500 | 10000 | 1:30 / 1:20 | 720 |
| | 320 / 500 / 800 | G10000 | 16000 | 1:50 / 1:30 / 1:20 | 450 |
| | 320 / 500 / 800 / 1300 | G16000 | 25000 | 1:80 / 1:50 / 1:30 / 1:20 | 288 |
| | 320 | G16000 E | 32000 | 1:100 | 225 |


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## 2.3 System Components

The FLOWSIC600 measuring system consists of the following hardware components:

- Meter body
- Ultrasonic transducers
- Signal processing unit SPU

The MEPAFLOW600 program may be used to facilitate operation, configuration and diagnosis.

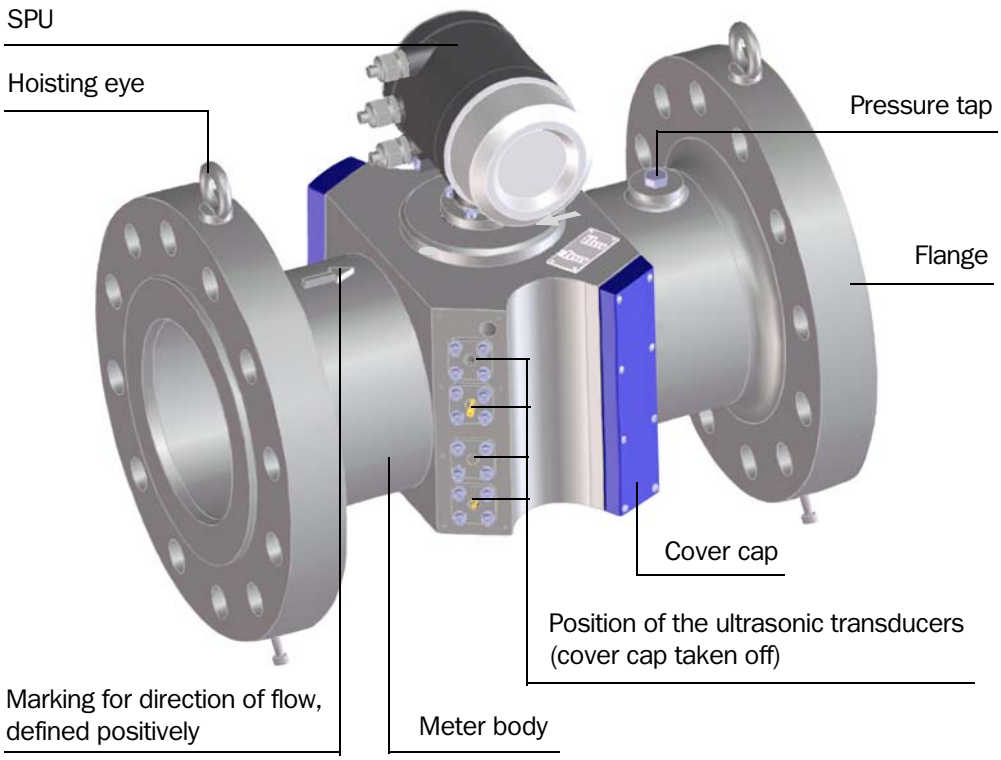


Fig. 2.3: FLOWSIC600

### 2.3.1 Meter body

The meter body consists of a middle section for mounting the ultrasonic transducers, and flanges used for installing the equipment in the pipeline. The meter body is, up to size of 24“, made of a single-piece casting, which is machined on precision equipment to ensure high reproducibility of the geometrical parameters. Flanges at meters larger than 24“ are welded onto the middle section.

The internal diameter, shape of the sealing surface, and standard dimensions of the connection flanges are in accordance with the specifications in the type key definition. The meter body material is chosen to suit customer requirements. Standard meter bodies are available in carbon steel and stainless steel.

The meter bodies can be delivered in several nominal sizes (see Section *2.2.4*).

### 2.3.2 Ultrasonic transducers

The FLOWSIC600 ultrasonic transducers are optimised to suit the system requirements. The high quality of the transducer parameters provides the basis for accurate and highly stable propagation time measurements with nanosecond precision. The ultrasonic transducers are of an intrinsically safe design (class "ia").


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### 2.3.3 Signal processing unit

The SPU contains all the electrical and electronic components required for controlling the ultrasonic transducers. It generates transmission signals and uses the received signals to calculate the measuring values. The SPU also contains several interfaces for communication with a PC, or standardised process control system.

Event logging see Section *2.7*

The current volume count, faults, warnings, and power failure alarms are stored in a non volatile data memory (FRAM) together with a time stamp. On system restart, the counter reading that was last saved is restored as the start value for the volume counter. The FRAM back-up provides an unlimited number of writing cycles and protects the saved data for at least 10 years.

The SPU is supplied with a front panel containing a two-line LCD to display current measured values, diagnosis and logbook information (see **Fig. 2.4**). You can select the values you want to be displayed using a magnetic pen while the front cover stays closed (for details on operation and menu structure see Section *9.2* in the appendix).

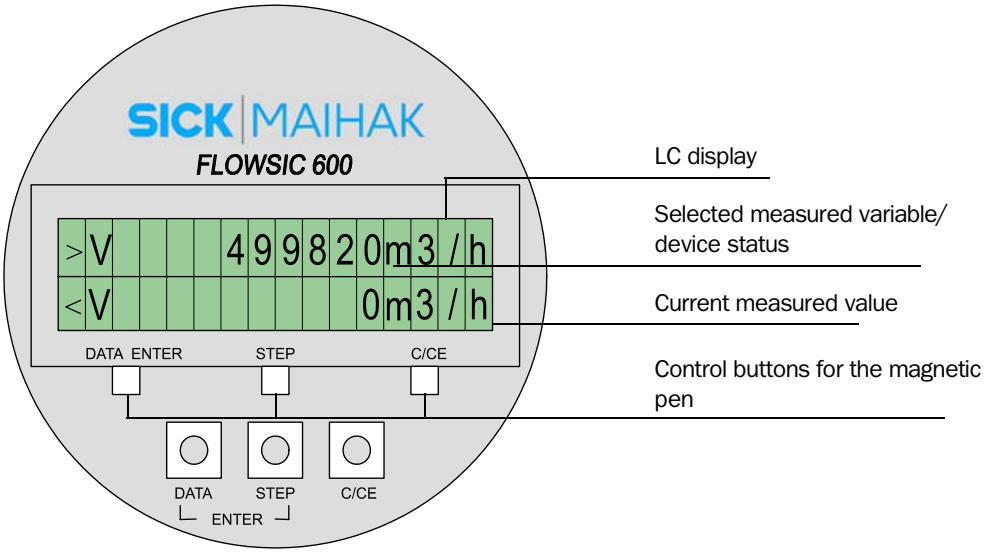


Fig. 2.4: FLOWSIC 600 SPU front panel

The power supply and interface terminals are located on the back of the SPU in a separate terminal box (see Section *3.4.4*).

The electronics is mounted in a housing certified to EN 50018 or IEC 60079-1 with type of protection "d" (flameproof enclosure). The transducer circuits are of an intrinsically safe design (type "ia").

### 2.3.4 MEPAFLOW600 diagnosis and configuration software

Information on installation and use of the program can be found in the software manual.

The MEPAFLOW600 program (menu-based configuration and diagnosis of the FLOWSIC600 system) allows all system parameters to be accessed, displays diagnosis information and can be used as a convenient tool for data recording.


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## 2.4 Measuring Principle

The FLOWSIC600 takes advantage of the principle of measuring the transit time difference of an ultrasonic pulse. It is equipped with one, two or four pairs of ultrasonic transducers. The transducers of a pair are integrated into a meter body and arranged opposite one another at a defined angle to the flow axis, thereby forming a direct measuring path (see **Fig. 2.5**).

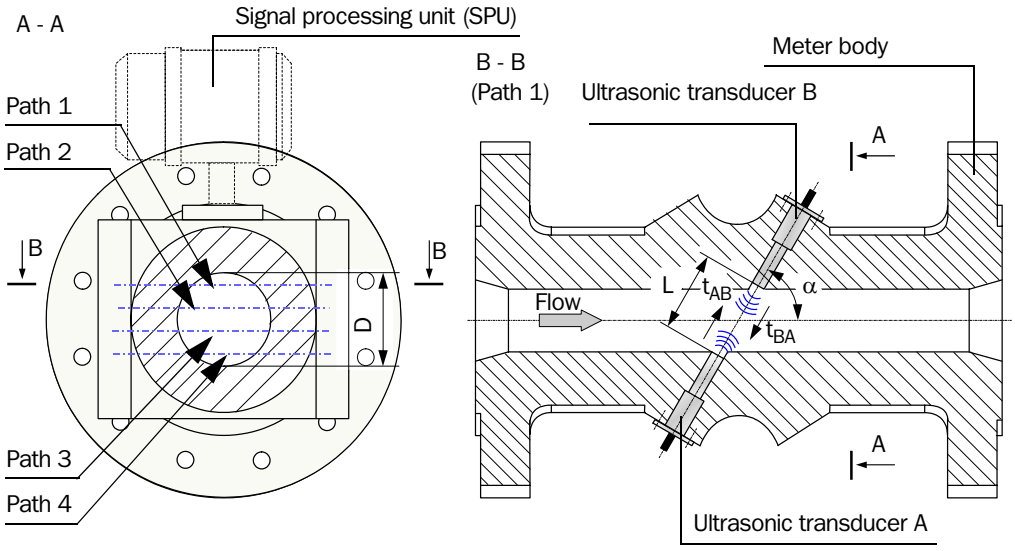


Fig. 2.5: FLOWSIC600 measuring principle

The ultrasonic pulses run through the meter body from transducer to transducer. With no gas flowing, the pulses propagate at the same velocity (namely the velocity of sound) in both directions. When a gas is flowing through the meter body, the pulse that propagates in the direction of the gas flow is faster, while the pulse that propagates against the flow is slower. This means that the transit time is shorter in the direction of flow ($t_{AB}$) and longer against the direction of flow ($t_{BA}$).

The ultrasonic transducers alternately act as a transmitters and receivers. Each transducer is a piezoceramic element that is coupled with a diaphragm. To transmit signals, an alternating voltage is applied to the piezoceramic element so that it vibrates mechanically (piezoelectric effect). These vibrations are then transferred by the diaphragm to the gas. The waves are transferred to the piezoceramic element in the form of mechanical vibrations. They are then converted into an electrical signal by the inverse piezoelectric effect and used for further signal analysis.

The signals are then processed to calculate the transit times of the acoustic signals through the flowing medium. The measured values can then be calculated from the transit times thus determined.


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### 2.4.1 Determining the gas velocity

**Measuring cycle**

With four paths → 40 measurements per second

In the operating status „Measurement“, the FLOWSIC600 determines the gas velocity on every measuring path 10 times per second. One measuring cycle consists of a velocity measurement per path, the integration of the operating volume, several internal procedures and the update of the measuring value output channels. Such a cycle takes about 100 ms.

**Determining the transit time of the ultrasonic signals**

A full analysis of the ultrasonic signals makes it possible to determine the point of time of signal reception, and thus the delay to the point of time of signal transmission. The signal propagation times in the flowing gas, $t_{AB}$ and $t_{BA}$, are determined on the basis of this delay.

Sound transit time in the direction of flow $t_{AB}$:

$$t_{AB} = \frac{L}{c + v_{Path} \cdot \cos \alpha}$$

Sound transit time against the direction of flow $t_{BA}$:

$$t_{BA} = \frac{L}{c - v_{Path} \cdot \cos \alpha}$$

L: Measuring path length
c: Velocity of sound
$v_{Path}$: Path velocity
$\alpha$ : Angle between the longitudinal axis of the meter body and the path

**Path velocity**

The path velocity ($v_{Path\ i}$) is calculated from the difference between the two transit times:

$$v_{Path\ i} = \frac{L\,i}{2 \bullet \cos \alpha\, i} \cdot \left( \frac{1}{t_{AB\ i}} - \frac{1}{t_{BA\ i}} \right)$$

i: Path number 1 ... 4
$v_{Path}$: Measuring values in the registers #7507 to #7510 “V i”
$\alpha$ i: Register #7101 to #7104

L i: Distance between the two transducer diaphragms.
This distance is calculated by subtracting the length of the transducers used (register #7109 to #7116 “SensorLength I AIB”) from the distance between the transducer seats in the meter body (register #7105 to #7108 “Length i”).
$L\,i = L_{Meter\ body\ i} - (L_{Transducer\ A\ i} + L_{Transducer\ B\ i})$

**Mean path velocity**

The most recent 100 measuring results (path velocity and measurement status) are stored in a variable mean value memory. If no valid path velocity was determined due to a negative plausibility check, such condition is also stored in the mean value memory. The mean value memory is organised as a FIFO memory. This means that the most recent entry always overwrites the oldest one. The mean path velocity $v_{avg\ i}$ forms the mean value of all valid measuring values stored in the memory.

$$v_{avg\ i} = \frac{\sum v_{Path\ i}}{\text{all valid values}\ N_{valid}}$$

The ratio of valid and invalid measurements in the mean value memory is used as a quality parameter (register #3008 to #3011 “% Error i”). If the proportion of invalid measuring results exceeds a certain threshold (register #3514 “Limit% - Error”, manufacturer constant = 95 %), the path is not used in the calculation of the flow velocity. In such a case, a replacement value may be determined for the faulty path in order to compensate the failure (see Section *2.8*).


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**Flow velocity**

The mean value of the weighted sum of all four path velocities is the flow velocity through the profile of the meter body (register #7004 “AvgVelGas”).

$v_A$: Flow velocity

$w_i$: Weighting factor of a:
- measuring path
- Register #7120 to #7123 “Weight i”

$$v_A = \frac{1}{4} \sum_{i=1}^{4} w_i \cdot v_{avg\,i}$$

### 2.4.2 Calculating the volumetric flow rate

The uncorrected volumetric flow rate $Q_v^*$ is calculated from the determined flow velocity $v_A$ and the open cross-sectional area in the meter body:

D: Internal diameter of the meter body, Register #7100 “PipeDiameter”

$$Q_v^* = v_A \cdot \frac{D^2 \cdot \pi}{4}$$

This intermediate result is still dependent on the Reynolds number and the properties of the flow profile (asymmetry, swirl). It is corrected using the following formula:

$$Q_v = Q_v^* \cdot (1 + f\,[Q_v^*, p_{abs}, CC_{0...4}, PF, K_{0...5}])$$

Profile factor:

$$PF = \frac{v_{avg\,1} + v_{avg4}}{v_{avg\,2} + v_{avg3}}$$

Gas pressure working point:
mean pressure in the working range, register #7041 “PressureAbsFix”.

see also Section *5.1.3*

$$p = \sqrt{p_{min} \cdot p_{max}} + 1\ \text{bar}$$

The sets of factors $CC_0$ to $CC_4$ and $K_0$ to $K_5$ are nominal width-dependent constants which were determined by the manufacturer and which are related to a particular FLOWSIC600.

**Correcting the impact of pressure and temperature on the geometry of the meter body**

The geometry parameters of the meter body are related to an ambient temperature of 20 °C and 1 bar(a) and have been optimised with view to minimum deviations due to the influence of pressure and temperature. However, there is still an impact of pressure and temperature on the geometry of the meter body and thus on the measured value. This impact is corrected as follows:

T: Register #7040 “TempAbsFix“

p: Register #7041 “PressureAbsFix“

$K_T$: Register #7118 “ExpCorrTemperature”

$K_p$: Register #7117 “ExpCorrPressure”

$$Q_{v,\,corr} = Q_v \cdot (1 + K_T \cdot (T - 293.15) + K_p \cdot p)$$

The temperature coefficient $K_T$ is material-specific and amounts to $4.12 \cdot 10^{-5}\ K^{-1}$ for carbon steel and $5.23 \cdot 10^{-5}\ K^{-1}$ for special steel.

The pressure coefficient $K_p$ was determined to be $6 \cdot 10^{-6}\ bar^{-1}$.

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**Correcting the characteristic line**

The characteristic line may be corrected using a factor dependent on the direction of flow ($AF_{forward}$, $AF_{reverse}$). In addition, a zero offset (ZO) may be entered. However, it should have the value 0 with a properly working device.

$AF_{forward}$: Register #7037 "AdjustFactorForward"; standard value 1.0

$AF_{reverse}$: Register #7038 "AdjustFactorReverse"; standard value 1.0

ZO: Register #7039 "ZeroFlowOffset"; standard value 0.0 [m³/h]

$$Q_{v,\,cal} = Q_{v,\,corr} \cdot AF_{forward} + ZO \qquad \text{for a positive direction of flow}$$

$$Q_{v,\,cal} = Q_{v,\,corr} \cdot AF_{reverse} + ZO \qquad \text{for a negative direction of flow}$$

The calculation of the factors is based on the weighted mean error (WME, equivalent to OIML recommendation no. 32).

Q: Checked flow rate

$Q_{max}$: Checked maximum flow rate

fi: Error in % determined for the checked flow rate

$$WME = \frac{\sum_{i=1}^{n} k_i \cdot f_i}{\sum_{i=1}^{n} k_i}$$

with $k_i = \frac{Q_i}{Q_{max}}$ for $Q_i \le 0.7\ Q_{max}$

and $k_i = 1.4 - \frac{Q_i}{Q_{max}}$ for $0.7\ Q_{max} < Q_i \le Q_{max}$

The corresponding factor is then calculated as follows:

$$AF = \frac{1}{1 + \frac{WME}{100\ \%}}$$

The result of the volumetric flow calculation is stored in register #7001 "VolumeFlow".

### 2.4.3 Calculating the actual volume

The operating volume is calculated from the operating volumetric flow rate $Q_{v,\,cal}$ by integration over time of the measuring intervals.

$T_s$: Measuring interval between two measurements

$$V_i = Q_{v,\,cal} \cdot T_s$$

The total aggregated volume is stored in the operating volume counters for both directions of flow. The operating volume counters cannot be reset.

#5010 "ForwardVolume"

#5012 "ReverseVolume"

While the system is in the "Invalid measurement" status, the volumes determined are stored in separate error volume counters. These counters can be reset. Such a reset is recorded in the logbook together with date and time stamp.

#5011 "ForwardVolumeErr"

#5013 "ReverseVolumeErr"

The resolution of aggregated volumes per volume unit [m3] is defined in register #5014 "TotalizerResolution". When reading the volume counters (#5010 to #5013), the corresponding resolution (see Table below) must be considered.

$$V = \text{Volume register value} \cdot \frac{\text{Counter resolution}}{1000}\ [m^3]$$


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**Counter resolution**

| | Resolution [$m^3$] | Register #5014 |
|---|---|---|
| DN 80 (NPS 3) | 0.01 | 10 |
| DN 100 (NPS 4) | | |
| DN 150 (NPS 6) | 0.1 | 100 |
| DN 200 (NPS 8) | | |
| DN 250 (NPS 10) | | |
| DN 300 (NPS 12) | | |
| DN 350 (NPS 14) | | |
| DN 400 (NPS 16) | | |
| DN 450 (NPS 18) | 1.0 | 1000 |
| DN 500 (NPS 20) | | |
| DN 600 (NPS 24) | | |

**Low flow suppression**

If the current flow rate falls below a preset threshold (register #7036 “LowFlowCutOff”), the calculated volumetric flow is set to zero. The current calculated flow velocity is not affected by this. The threshold is set to 0.25 $Q_{min}$ at the factory.

### 2.4.4 Determining the velocity of sound

The actual velocity of sound c in the gas under current operating conditions is calculated from the sum of the two measured propagation times $t_{AB\,i}$ and $t_{BA\,i}$ of a path.

$$c_i = \frac{L_i}{2} \cdot \left( \frac{1}{t_{AB\,i}} + \frac{1}{t_{BA\,i}} \right)$$

$$c = \frac{1}{4} \sum_{i=1}^{4} c_i$$

A theoretical velocity of sound can be derived from the gas composition, pressure and temperature values. This theoretical velocity of sound and the measured velocity of sound should be identical. The velocity of sound thus provides an excellent possibility of system diagnosis.


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## 2.5 Operating States and Signal Output

The FLOWSIC600 has the following operating states:

- Measurement
- Maintenance required
- Configuration
- Malfunction

Any operating states are recorded in the logbook together with the time stamps of begin and end of occurrence.

### 2.5.1 Measurement

The “Measurement” status is the standard status of the FLOWSIC600. Frequency outputs and current output are updated cyclically and indicate the actual volume and volumetric flow rate. The digital output “Direction of flow” is updated in accordance with the sign of the volumetric flow. The digital output “Valid measurement” (active) represents the status of the measurement. Positive (forward) and negative (reverse) volumetric flow rates are integrated and saved in separate internal memory sections.

The Modbus interface allows to query all parameters and signals at any time without interfering with the function of the system.

Each measurement initiated by the system controller includes one full transit time measurement along and one against the direction of flow in each path. The result of each measurement is written to a variable mean value memory to be used in further calculations. The size of this memory block and thus the device response delay can be modified through the parameter in register #3502 “AvgBlockSize”. If no result can be calculated due to deficient signal quality, this measurement is registered as an invalid attempt in the mean value memory. The mean value is formed in a variable averaging process including all valid measured values in the memory.

If the number of invalid measurements in a path exceeds a predefined limit (register #3514 “Limit%Error”), the measuring system will turn into the “Maintenance required” status.

### 2.5.2 Maintenance required

This status becomes active if one measuring path has failed and the adaptive path failure compensation has been activated. For multi-path system the FLOWSIC600 is able to compensate this failure. Measurement is continued with reduced accuracy. If a path fails while the path failure compensation is deactivated, the measuring system will turn into the “Malfunction” status.

### 2.5.3 Configuration

The “Configuration” status is used to modify parameters and to test the system and output signals. The digital output “Measurement valid” is deactivated in this mode because invalid measured values may be produced. The system continues operation using the current sample rate and executes all calculations as in the “Measurement” mode. Frequency output and analog output may represent test values and do thus not necessarily indicate measured values. Any parameter modifications are applied immediately to the running calculations, with the exception of the sample rate, baud rate of the Modbus interface/device address.


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The test cycle can be activated for a measuring path by setting the corresponding control bit in the System Control Register (#3002) (see software manual). In a test cycle, the transmitted signal is fed to the received signal amplifier of the measuring path through an electric attenuation unit (transducer simulator). This function can only be activated if the system is in the “Configuration” status. It is used to test a path-specific electronic module.

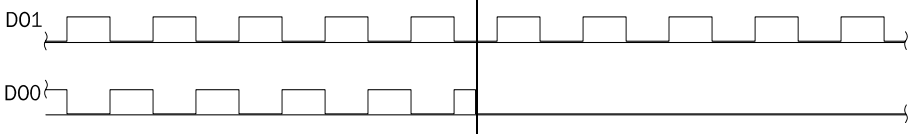
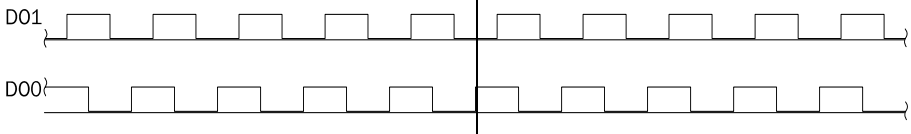
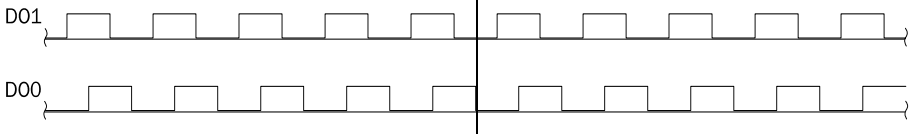
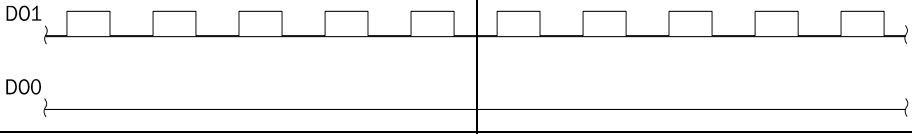
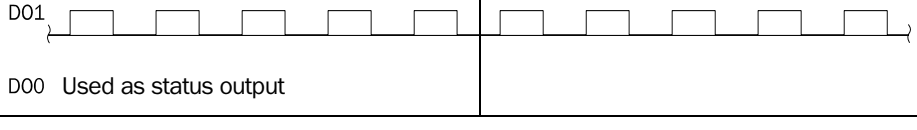
Possibly active test cycles are automatically cancelled when leaving the “Configuration” status.

### 2.5.4 Malfunction

If the quality of received signals is deficient in more than one measuring path, the device must mark the measured value invalid. However, the device will cyclically try to re-establish valid measurements. As soon as the signal quality and number of valid measurements permit this, the device will automatically change back to the “Measurement” or “Maintenance required” mode.

### 2.5.5 Pulse output and status information

TYPE APPROVAL

| **Output, signal** | | | **Output value in operating status** | | | |
|---|---|---|---|---|---|---|
| | | | **Measurement** | **Maintenance required** | **Configuration** | **Malfunction** |
| “Measured value” pulse signal | Inverted with error signal * | |   | | | |
| | Phase shift 90 ° ** | Positive flow rate |   | | | |
| | | Negative flow rate |   | | | |
| | Separate outputs for each direction ** | Positive flow rate |   | | | |
| | | Negative flow rate | | | | |
| | Single pulse output ** | |   | | | |

* Default setting on delivery
** Optional setting on customer request

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| **Output, signal** | **Output value in operating status** | | | |
|---|---|---|---|---|
| | **Measurement** | **Maintenance required** | **Configuration** | **Malfunction** |
| "Maintenance required" Status signal | Status "active / inactive" * Measurement valid | Status "active / inactive" * Compensation of path failure | "undefined" | "undefined" |
| "Direction of flow" Status signal | Status "active / inactive" * Positive or negative direction of flow | Status "active / inactive" * Positive or negative direction of flow | "undefined" | "undefined" |
| "Warning" | Status "active / inactive" * | Status "active / inactive" * | "undefined" | "undefined" |
| LC display | >V 123456 m³<br><V 1234 m³ | 1234 m³<br>Display flashing | FLOWSIC600<br>Configuration | >V 123456 m³<br><V 1234 m³<br>Display flashing |
| Serial port RS485 | • Measured value, diagnosis information and parameters<br>• Measuring data logging, diagnosis and configuration through the MEPAFLOW600 program (see software manual)<br>• Connection with external process control equipment through implemented MODBUS protocol (data polling) | | | |

*: The "active" or "inactive" state can be assigned to the electric switch status "normally open" or "normally closed" by configuration in the MEPAFLOW600 control and configuration program (see software manual).
The default setting for Maintenance required, Configuration and Malfunction is "normally closed".

Digital output 2 is assigned by default with the status signal "Maintenance required", and digital output 3 with the status signal "Direction of flow". Alternatively, digital output 3 may be assigned with the status signal "Warning" in the course of the official verification procedure.

The LC display shows by default the two major counters, one for each direction of flow. In the course of the official verification procedure, it is possible to define an alternative display content, such as the error volume counters for each direction of flow. The display then switches between these two contents every 5 seconds.

Changes in the logbook status are indicated by a flashing character at the far right end of the first line of the display. The character depends on the status:

- "I" for information

- "W" for warning

- "E" for error

The character will disappear after acknowledgement. Details on reading the logbook entries, their acknowledgement and about the menu structure can be found in Section 9.2.


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## 2.6 Self-diagnosis

In the measurement status, the ratios of sound and path velocities, amplification settings, and signal-to-noise ratios are continuously monitored. If these values exceed fix set thresholds, a warning signal will be generated. This allows immediate measures to be taken to prevent possible system malfunctions.

During commissioning or operation, the signal thresholds can be adapted to suit individual application requirements. This allows the status warning system to be optimised.

**Note** The "Warning" status signal does not affect the functionality of the device.

| | **Threshold** | **Warning message** | **Notes** |
|---|---|---|---|
| Velocity of sound | < 5 m/s | Warning VOS Deviation | This message will be produced if the current measured path sound velocity deviates from the mean value of the mean sound velocities calculated for all the paths by more than the specified threshold value.<br>The current flow velocity is used as a weighting factor, so that temperature stratification is disregarded at very low flow velocities.<br>Used to indicate whether or not the path is measuring the correct transit time.<br>**Note**<br>When setting the parameter, take into account plausible conditions for normal operation (in particular temperature stratification). |
| Signal amplification | < 6 dB | Warning AGC Deviation | The absolute difference between both path gain factors is evaluated and must remain below the threshold value.<br>**Caution**<br>High flow velocities may also increase the difference in gain. |
| | < 93 dB | Warning AGC Limit | The absolute value of the reception gain is monitored.<br>**Caution**<br>The current reception sensitivity largely depends on the current process pressure (inversely proportional in initial approximation, that is, if the pressure doubles, the required reception sensitivity will be halved). |
| | | | If one of the alarms is triggered by a path, this can indicate a malfunction in the ultrasonic transducers, electronic modules, transducer cables or parameter settings (signal models, control thresholds). |
| Signal-to-noise ratio | < 13 dB | Warning SNR | This alarm will be activated if the signal-to-noise ratio becomes too small.<br>Possible causes for this include interfering noise caused by fittings in the pipeline, valves that are not fully open, sources of noise near the measuring location, or defective ultrasonic transducers. |

Additional signal and system diagnosis functions monitor the reliability of the measured values, by checking the plausibility of the ultrasonic signals received and the ultrasound signal transit times calculated from them.

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## 2.7 Event Logging

Important system events (max: 250) are stored in a logbook. Each entry consists of the event, time stamp and the volume counter readings valid at that time, along with acknowledgement status. The events are logged continuously in the order they occur. Each event can be acknowledged manually. Logbook queries provide information on the number of registered events and the remaining memory space. The entries are classified as follows:

- Active events
- Inactive acknowledged and unacknowledged events
- Acknowledged events

If there is no space left in the logbook, the logbook is closed and the system signals a malfunction. Until the logbook is reset (deleted), the measured volumes are stored in the error volume counters, in accordance with the direction of flow, irrespective of the measuring accuracy.

**Overview of event entries**

| | **Class** | **Description** | **Value (second line on the display)** |
|---|---|---|---|
| Power on | "I" information | System was cold started or rebooted after a watchdog reset. | Time stamp of the last stored counter reading is considered to be the time of the "Power off" event. |
| Change of operating mode | "I" information | System was changed to the configuration mode after password input, or back from the configuration mode to the measurement mode. Parameters that affect the measured values may have been modified. | Activated password level |
| Error volume counter reset | "I" information | Resetting the error volume counters to zero | Reset volume |
| Counter overflow | "I" information | One of the four volume counters has run through completely. | |
| Logbook reset | "I" information | Entire logbook was deleted ("Reset" is always the first entry and indicates the point of time the logbook was opened.) | |
| Set clock | "I" information | Date and/ or time register of the real time clock was/ were changed. | Time stamp of the change |
| Maintenance required | "W" warning | The measured value of one path must be substituted by the replacement value calculation routine. | Path index and cause for deactivation |
| Output range | "W" warning | The current measured value can no longer be represented by the pulse output, because the maximum output frequency was reached. | |
| Measurement invalid | "E" error | More than one path must be substituted by the replacement value calculation routine, or the activated adaptive path failure compensation has not been activated. | Value is assigned with the four path states |
| System error | "E" error | Reliable operation of the system is not guaranteed. | Cause of the fault<br>• CRC program code<br>• CRC parameters<br>• CRC counter reading<br>• CRC replacement path weights<br>• Implausible parameter<br>• DSP fault |
| Logbook full | "E" error | No memory space – further events cannot be logged. The system will turn into the "Malfunction" status. | |


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## 2.8 Path Failure Compensation

TYPE APPROVAL

For a 4 path system the FLOWSIC600 is able to compensate the failure of one, max. two paths using a static or an adaptive compensation routine. Path failure may be caused by an invalid signal, the AGC level exceeding the limit and/ or problems in processing received signals in the DSP.

The measured value of the failed path is substituted by a calculated replacement value. This replacement value is calculated on the basis of the current valid values measured in other paths and the relation of gas velocities among the individual paths. The relation among the paths for valid measurements are defined by the individual flow profile situation in the installation. This relation is continuously calculated and saved during undisturbed measurement operation.

Field studies have shown that it makes sense to distinguish between two regions (low velocity and medium to high velocity). The relation of gas velocities among the paths are stored separately for each of these two regions.

It is recommended to teach the path relations during the commissioning procedure, because they are different in each individual mounting situation (see software manual, “Device parameters” tab).

**Determination of path relations**

During normal operation, the individual path relations $P_{Path}$ are calculated continuously.

$$P_{Path\ i} = \frac{v_{Path\ i}}{v_A} \qquad (1)$$

$v_A$: Mean area velocity

N: Number of measuring paths

$w_i$: Weighting factor of a measuring path

The mean area velocity is calculated as follows:

$$v_A = \frac{1}{N} \sum_{i=1}^{N} w_i \cdot v_{Path\ i} \qquad (2)$$

These relations are used in an adaptive mean value calculation routine for each individual path. Statistical variation caused by turbulence is sufficiently suppressed with the help of this mean value calculation. This algorithm further allows the measuring system to adapt to different flow profiles caused by changing operational conditions.

After starting the system, the average path relation values are calculated on the basis of at least 10,000 single measurements (parameter Register #5009 “PathCompValid”), starting from standard values. This usually takes about 10 min. The standard value of this parameter is based on experience, and is set by default so that no additional adjustment is necessary when commissioning the FLOWSIC600.

When the average path relations have been established based on the required minimum number of single measurements, the path relations are marked valid and the system is now able to compensate path failure. The variable mean value calculation is turned on at the same time. The default attenuation constant for this teaching algorithm (Register #7206 “PathCompAverWeight”) ensures that statistical variation is suppressed.

The mean values for low (1-8 m/s) and high flow velocities (> 8 m/s) are determined separately (see table below). This improves the result of the compensation because the path relations are more stable at higher flow velocities. The path relations are not taught below 1 m/s.


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| | Parameter | Description | Notes |
|---|---|---|---|
| < 1 m/s | | | No path relation adaption<br>In case of failure, the stored path relations for low flow velocities (1-8 m/s) are used. |
| 1 ... 8 m/s | #7208 | PathCompClassLo | Continuous calculation and adaption of the path relations<br>The results are saved in the “low flow” class registers #7289 - #7292 (path 1-4). |
| > 8 m/s | #7207 | PathCompClassHi | Continuous calculation and adaption of the path relations<br>The results are saved in the “high flow” class registers #7285 - #7288 (path 1-4). |

**Adaptive compensation of one or more path failures**

If the self-diagnosis routine implemented in the system detects a path failure, the velocity value for the failed path will not be used for the calculation of the mean area velocity $v_A$ (Equation 2). If this occurs, the following formula will be used to calculate the mean area velocity based on the applicable measured values for the remaining paths and the stored adapted path relations.

$b_i$: Status bit for path i
$b_i = 0$: Path inactive
$b_i = 1$: Path active

$$v_A = \frac{\sum_{i=1}^{N} b_i \cdot w_i \cdot \frac{v_{Path\ i}}{P_{Path\ i}}}{\sum_{i=1}^{N} b_i \cdot w_i}$$

The system indicates that a path failure is being compensated with the "Maintenance required" signal. A greater measurement uncertainty of less than ± 0.35 % must be accepted with four-path systems when operating in this mode. The volume measured during that time is stored in the normal counters for each flow direction.

Multiple path failure is also compensated using the principle described above, but the system indicates this status with the "Measurement invalid" signal. The volume measured during that time is stored in separate error volume counters for each flow direction. This enables gas quantities transported to be determined despite an increased measurement uncertainty.

**Static compensation of one or more path failures**

If the adaptive path compensation routine is turned off, static path relations as shown in the table below are used for path failure compensation. These static values are based on data of several installations.

| | Path no. 1 | Path no. 2 | Path no. 3 | Path no. 4 |
|---|---|---|---|---|
| 2 | 1.000 | 1.000 | | |
| 4 | 0.915 | 1.030 | 1.030 | 0.915 |


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The system indicates this status with the "Measurement invalid" signal. The volume measured during that time is stored in separate error volume counters for each flow direction. This enables the gas quantities transported to be determined despite an increased measurement uncertainty.

**Note** In order to ensure that the system is able to compensate path failure at both high and low flow velocities, it is recommended to run the FLOWSIC600 during commissioning for 30 minutes at low gas velocities (< 8 m/s) first and then for 30 minutes at high gas velocities (> 8 m/s).

### Deactivation of the adaptive path failure compensation

If path failure compensation is not required, the calculation of the path relations can be suppressed by setting the attenuation constant (register #7206) to zero or by unchecking the corresponding checkbox in the MEPAFLOW600 program (see **Fig. 2.6**). In that case, only the static compensation described for single or multiple path failure will be active.

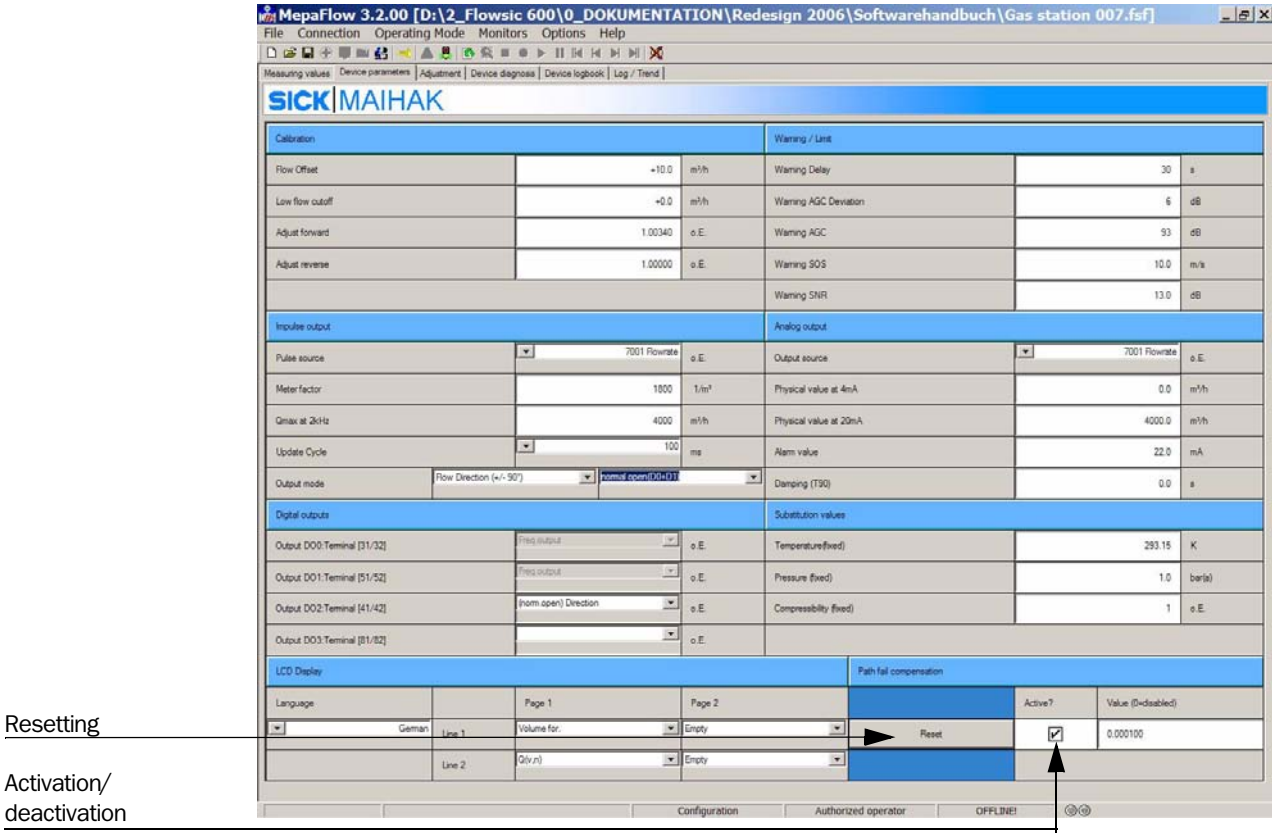


Fig. 2.6: MEPAFLOW600 program, “Device parameters” tab

Click the “Reset” button to reset the calculated path relations in the two velocity ranges.

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## 2.9 Configuration

### 2.9.1 Hardware variants and signal outputs

The output channels of the FLOWSIC600 can be configured in several ways. Different output configurations require different hardware variants of the electronic unit. A detailed description is contained in the service manual in section 3.

| | **Hardware variant/output configuration** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1/1** | **1/2** | **1/3** | **2/4** * | **2/5** * | **3/6** ** | **4/7** |
| 31/32 | Pulse | Pulse | Status | Analog | Analog | p, T Sensor HART | Analog |
| 33/34 | RS485 | RS485 | RS485 | RS485 | RS485 | RS485 | RS485 |
| 51/52 | Pulse | Pulse | Pulse | Pulse | Status | Pulse | Pulse |
| 41/42 | Status | Status | Status | Status | Status | Status | Status |
| 81/82 | Status | RS485 | Status | Status | Status | Status | RS485 |

* Can be fitted with HART® communication.

** This configuration is used to activate the internal flow correction function of the FLOWSIC600.

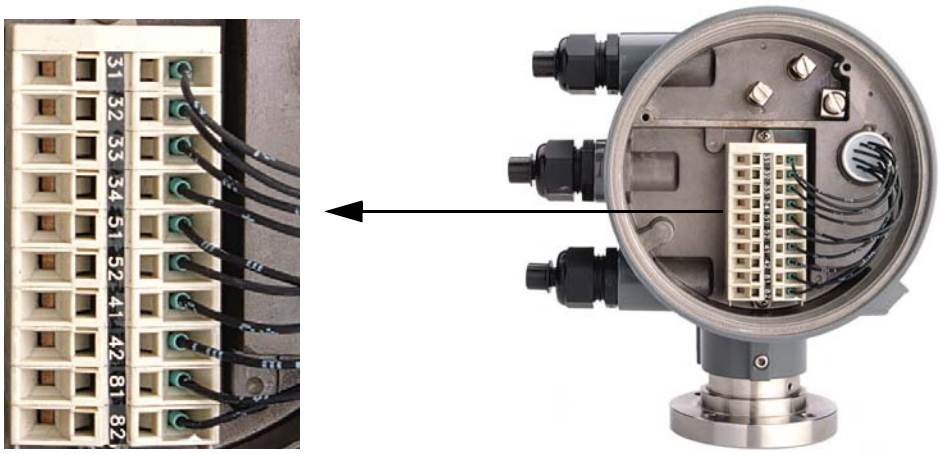


Fig. 2.7: Terminals in the FLOWSIC600 signal processing unit (cover opened)

### 2.9.2 System configuration with external volume corrector

Depending on individual requirments exists a wide range of variants to integrate the FLOWSIC600 into a gas facility. **Fig. 2.8** shows a basic configuration.


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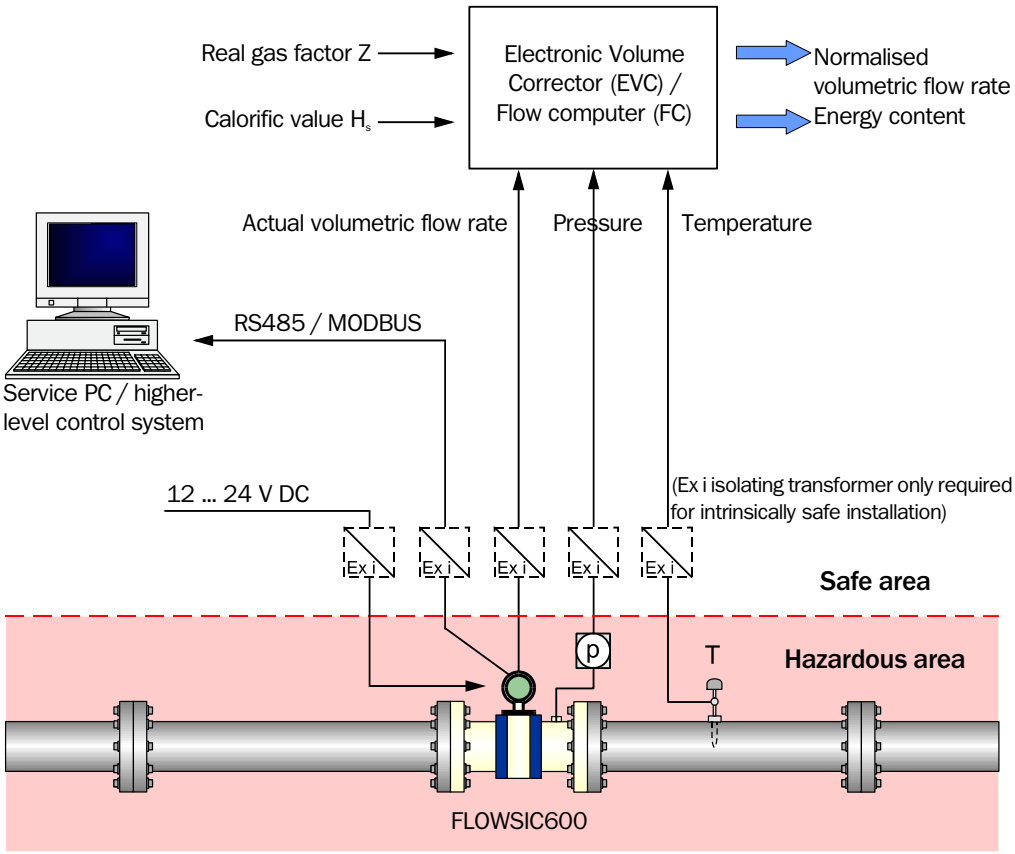


Fig. 2.8: FLOWSIC600 connection diagram

### 2.9.3 System configuration with integrated electronic volume corrector

#### 2.9.3.1 General

**Application description**

The functions utilized by the integrated electronic volume corrector (EVC) have been incorporated into the FLOWSIC 600 firmware as software function modules. The EVC calculates a normalized volume (Vn.c. at user specified reference conditions) from the measured actual flow, pressure and temperature. The output of the normalized volume (Vn.c.) is available as displayed value on the LC display, as a MODBUS register value and as a pulse output.

The calculation methodology for determination of the compressibility is based on the SGERG method and is applicable up to a pressure of 100 bar (1450 psi).

**Limitation of use**

When using the FLOWSIC600 with the integrated EVC, the flow computer normally required to standardize the volumentric flow, may not be required.

The EVC is not intended or approved for custody transfer applications (fiscal measurement).

**Reqirements**

The use of the FLOWSIC600 with integrated EVC requires the following program releases:

- Firmware: 3.0.00 or higher
- MEPA: 10.0.10 or higher


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**Calculation schematic**

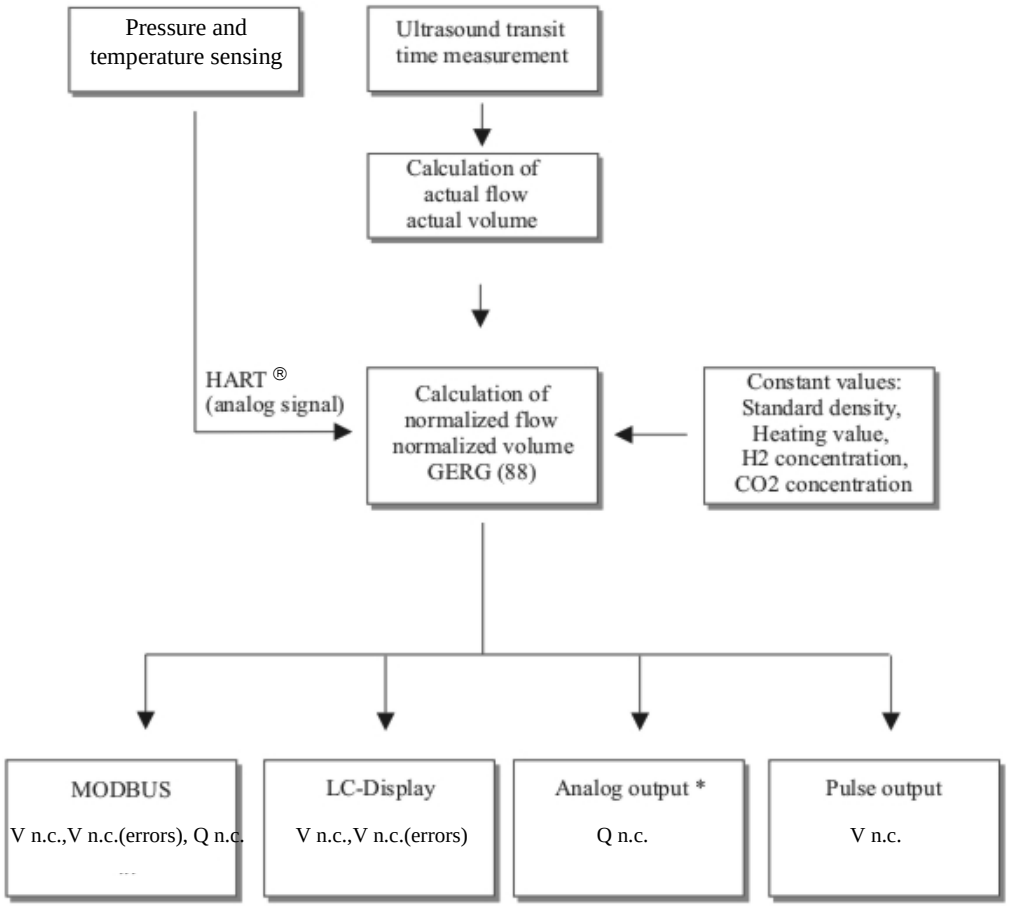


Fig. 2.9: Schematic diagram

The following formula is used to calculate the normalized volume:

$$Vnc. = Vac. \cdot \frac{Pac. \cdot Tnc.}{Tac. \cdot Pnc.} \cdot \frac{1}{K}$$

Vn.c.: Normalized volume
Va.c.: Actual Volume
Pn.c.: Normalized pressure
Pa.c.: Actual pressure
Tn.c.: Normalized temperature
Ta.c.: Actual temperature
K: Compressibility according to DVGW G486 SGERG

### 2.9.3.2 Assembly / Installation

The meter is installed in the same way as a standard FLOWSIC600 without the EVC (see chapter 3). To facilitate the added functionality of the EVC, a pressure and temperature transmitter will need to be installed and wired to the SPU.

### 2.9.3.3 Measurement of pressure and temperature

The analog output of the meter is used for the input of the pressure and temperature signals. The HART protocol is modulated onto this analog signal so that the measured values may be queried by the gas flow meter (EVC) in a fixed cycle. In order to realize pressure and temperature sensing, HART®-capable transmitters have to be used as a necessity. Since the transmitters are fed from the gas flow meter, the transmitters have to be supplied as SMART 2 wire devices.


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**Tested pressure transmitters**

- Manufacturer: Fisher Rosemount
  Type: 3051 CA, HART®, capable
  3051 S, HART® capable
  etc.
- Manufacturer: ABB
  Type: 264 HS, HART® capable

**Tested temperature measuring transmitters**

- Manufacturer: Fisher Rosemount
  Type: 644H A, HART® capable
  248H A, HART® capable
  etc.
- Manufacturer: ABB
  Type: TH01 - Ex, HART® capable

**Electrical connection**

The transmitters are parallel-connected to terminal 31/32. Through the connecting cables, the supply voltage is provided by the gas flow meter for both transmitters, and at the same time, the serial data protocol is transmitted according to HART®.

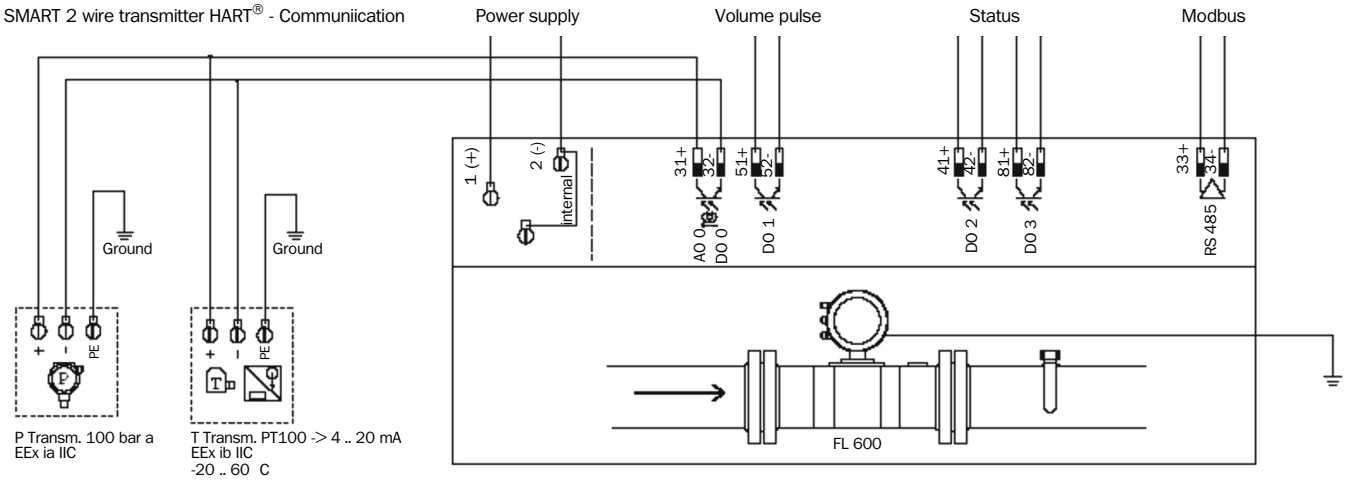


Fig. 2.10: Wiring of pressure and temperature transmitters

ATTENTION

**Important**

In this configuration with EVC, the analog I/O is used as input for the pressure and temperature transmitters. As such the analog I/O is not available as a standard output. To obtain an analog output signal, an additional DIN rail module may be used for frequency/analog conversion (Pepperl & Fuchs - KFD2 / UFC), with internal Ex-barriers, analog and frequency output.

The design and wiring of the transmitters can be intrinsically safe, Ex i as well as with increased safety, Ex e. When Ex i transmitters are connected, all other wires in the terminal compartment must also be connected to equipment having an EEx i marking.


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#### 2.9.3.4 Configuration of the EVC

The MEPAFLOW600 software supplied with the meter is used for the set-up and configuration of the EVC. The software should be opened on the ''Service'' access level with the password 'factory' (see **Fig. 2.11**).

The P and T transmitters should be configured with the following HARTBUS adresses:

Pressure transmitter: 1

Temperature transmitter: 2

These addresses must also be entered in the meter configuration in registeres#3540 and #3541 (see **Fig. 2.14**).

After start-up of the configured system, the meter can analyze the transmitters' actual long address which is then used to communicate the measured values. The recommended read cycle for the pressure and temperature is 30 s (see Tab.*2.1* and **Fig. 2.14**).

The set-up of the interface parameters for the HART®-Bus, which provides the pressure and temperature measurements, is performed by configuring the 'Factory settings / Interface settings' tab (see **Fig. 2.12**).

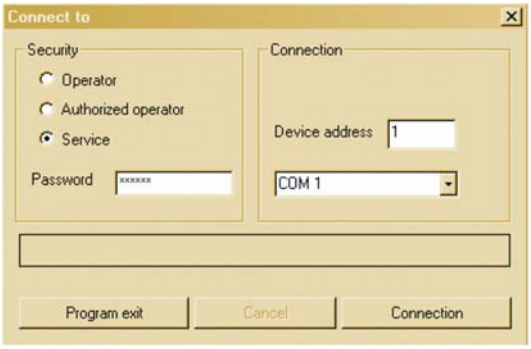


Fig. 2.11: 'Connection' tab

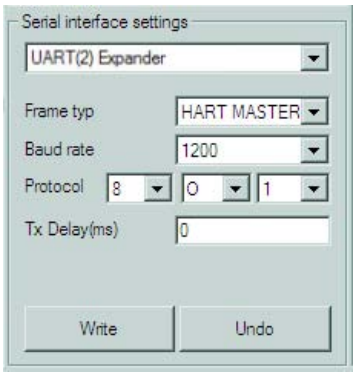


Fig. 2.12: 'Factory settings / Interface settings' tab

The integrated EVC is activated by setting register #3026 (FreqSourceReg) to the value 7002 (see **Fig. 2.13**).


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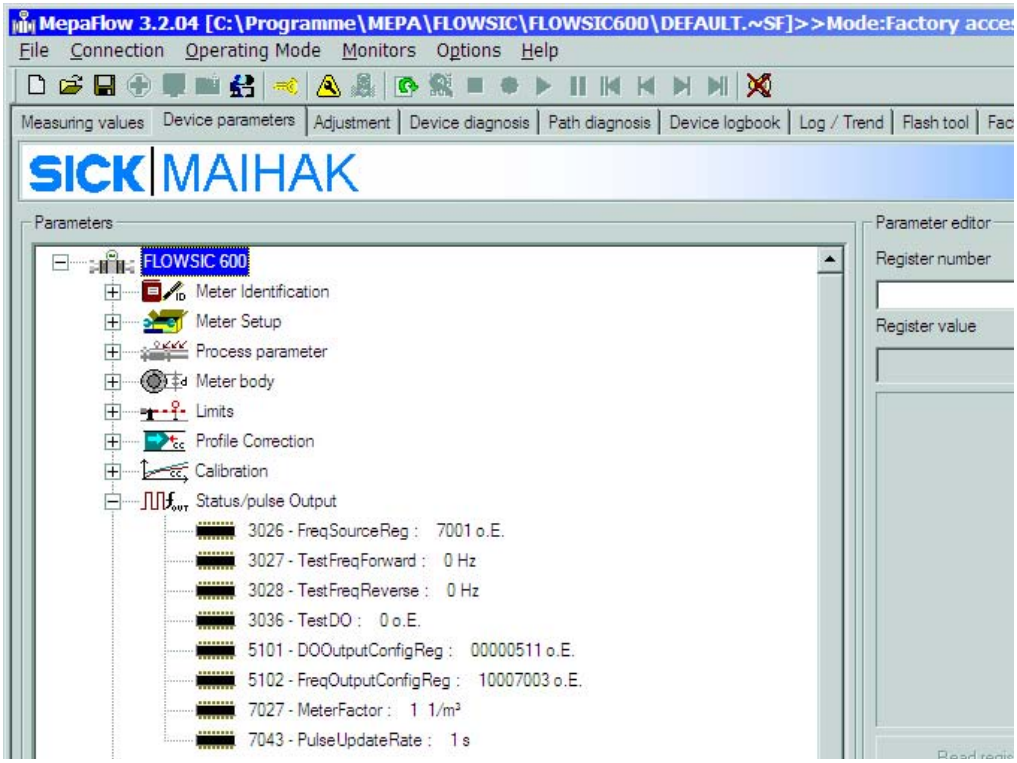
MepaFlow 3.2.04 [C:\Programme\MEPA\FLOWSIC\FLOWSIC600\DEFAULT.~SF]>>Mode:Factory acces
File Connection Operating Mode Monitors Options Help
Measuring values Device parameters Adjustment Device diagnosis Path diagnosis Device logbook Log / Trend Flash tool
SICK MAIHAK
Parameters
Parameter editor
Register number
Register value
FLOWSIC 600
Meter Identification
Meter Setup
Process parameter
Meter body
Limits
Profile Correction
Calibration
Status/pulse Output
3026 - FreqSourceReg : 7001 o.E.
3027 - TestFreqForward : 0 Hz
3028 - TestFreqReverse : 0 Hz
3036 - TestDO : 0 o.E.
5101 - DOOutputConfigReg : 00000511 o.E.
5102 - FreqOutputConfigReg : 10007003 o.E.
7027 - MeterFactor : 1 1/m³
7043 - PulseUpdateRate : 1 s

Fig. 2.13: 'Device parameters' tab

Depending on the contents of the registers #3026, #3542 and #3545, the functionality of the volume correction can be specified (see Tab.*2.1*). The configuration of these values is performed under the 'Device parameters' tab (**Fig. 2.14**).

| #3026<br>FreqSourceReg | #3542<br>HART_ReadIntervall | #3545<br>GergCalcIntervallMax | Functionality |
|---|---|---|---|
| 7001 | ? | ? | Volume correction is not activated; FL600 gives actual values. |
| 7002 | 0 | 0 | Volume correction is activated; correction is carried out by use of constant values (Temperature (fix) #7040, Pressure (fix) #7041, Compressebility (fix) #7042) |
| 7002 | e.g. 30s | 0 | Volume correction is activated; correction is carried out with the pressure and temperature readings (e.g. every 30 seconds) and the constant value Compressebility (fix) #7042 |
| 7002 | e.g. 30s | e.g. 30s | Volume correction is activated; correction is carried out with the pressure and temperature readings (e.g. every 30 seconds) and the calculated SGERG compressibility (e.g. every 30 seconds). |

Tab. 2.1: Configuration for the volume correction calculation

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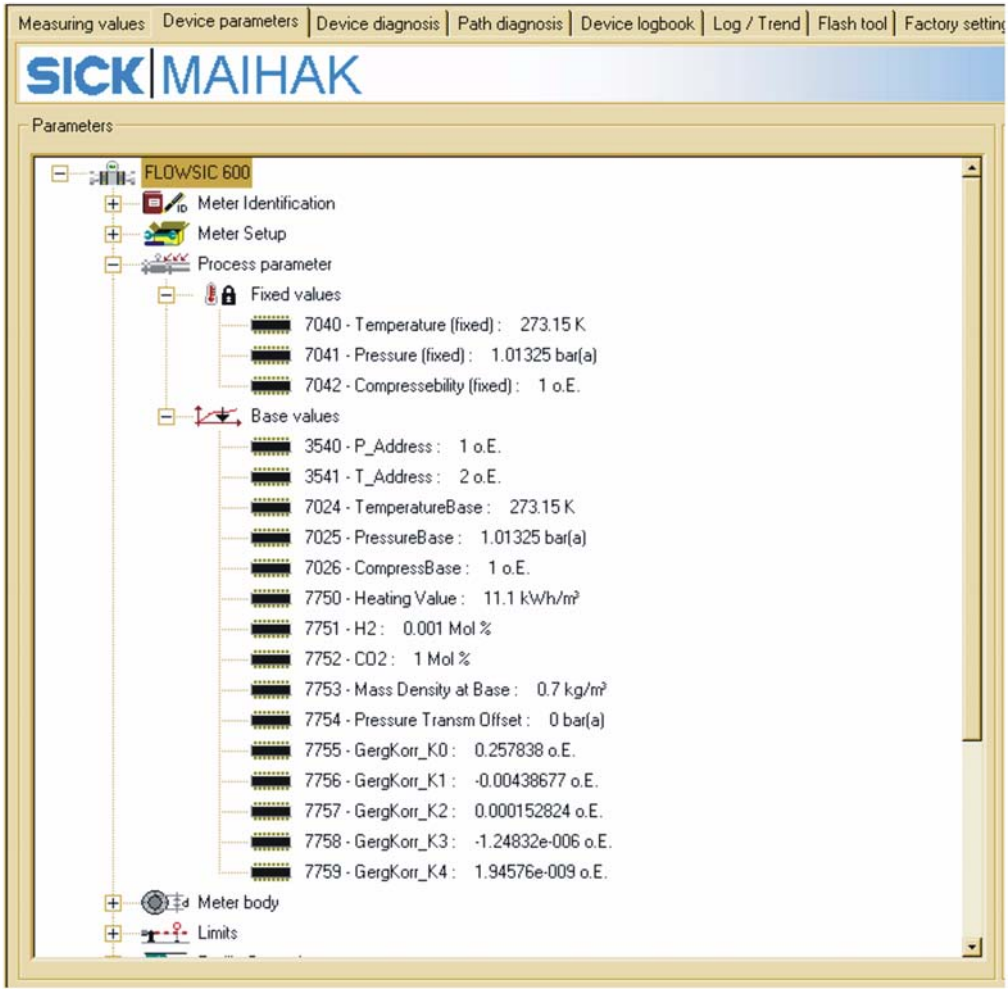
Measuring values
Device parameters
Device diagnosis
Path diagnosis
Device logbook
Log / Trend
Flash tool
Factory setting
SICK MAIHAK
Parameters
FLOWSIC 600
Meter Identification
Meter Setup
Process parameter
Fixed values
7040 - Temperature (fixed) : 273.15 K
7041 - Pressure (fixed) : 1.01325 bar(a)
7042 - Compressebility (fixed) : 1 o.E.
Base values
3540 - P_Address : 1 o.E.
3541 - T_Address : 2 o.E.
7024 - TemperatureBase : 273.15 K
7025 - PressureBase : 1.01325 bar(a)
7026 - CompressBase : 1 o.E.
7750 - Heating Value : 11.1 kWh/m³
7751 - H2 : 0.001 Mol %
7752 - CO2 : 1 Mol %
7753 - Mass Density at Base : 0.7 kg/m³
7754 - Pressure Transm Offset : 0 bar(a)
7755 - GergKorr_K0 : 0.257838 o.E.
7756 - GergKorr_K1 : -0.00438677 o.E.
7757 - GergKorr_K2 : 0.000152824 o.E.
7758 - GergKorr_K3 : -1.24832e-006 o.E.
7759 - GergKorr_K4 : 1.94576e-009 o.E.
Meter body
Limits

Fig. 2.14: 'Device parameters' tab

Beside the registers always described, additional registers may require the input of parameter values, particularly if the SGERG compressibility calculation is being implemented. See the following table for a description of each of those registers.


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| Register number | Name | Description |
|---|---|---|
| #3026, #3542, #3545 | See Tab.2.1 | See Tab.2.1 |
| #3540 | P_Address | Communication address of the pressure transmitter, must be identical in the transmitter and gas flow meter |
| #3541 | T_Address | Communication address of the temperature transmitter, must be identical in the transmitter and gas flow meter |
| #7024 | TemperatureBase | Standard condition for temperature to which the measured volume is normalized |
| #7025 | PressureBase | Standard condition for pressure to which the measured volume is normalized |
| #7750 | Heating Value | Average heating value of the gas |
| #7751 | H2 | Average hydrogen concentration |
| #7752 | CO2 | Average carbon dioxide concentration |
| #7753 | Mass Density at Base | Average standard density of the gas |
| #7754 | PressureTransmOffset | Mean local atmospheric pressure as an offset when overpressure transmitters are used.<br>When absolute-pressure transmitters are used, the parameter remains 0. |
| #7040 | Temperature (fix) | Is used for volume correction, when no current values provided by transmitter (e.g. at HART_ReadIntervall = 0) |
| #7041 | Pressure | Is used for volume correction, when no current values provided by transmitter (e.g. at HART_ReadIntervall = 0) |
| #7042 | Compressebility | Is used for volume correction, when the feature 'calculation of compressibility' is not activated (e.g. at GergCalcIntervallMax = 0) |
| #7755 | GergKorr_K0 | Correction factor for high-pressure polynomial adjustment (>100 bars, for natural gas only) |
| #7756 | GergKorr_K1 | Correction factor for high-pressure polynomial adjustment (>100 bars, for natural gas only) |
| #7757 | GergKorr_K2 | Correction factor for high-pressure polynomial adjustment (>100 bars, for natural gas only) |
| #7758 | GergKorr_K3 | Correction factor for high-pressure polynomial adjustment (>100 bars, for natural gas only) |
| #7759 | GergKorr_K4 | Correction factor for high-pressure polynomial adjustment (>100 bars, for natural gas only) |

Tab. 2.2: Configuration for the volume correction calculation

#### 2.9.3.5 Outputs

The following signal outputs are available on the meter:

- Terminal 51, 52: 1 x pulse output
  or analog signal via external frequency/analog converter
- Terminals 41, 42; 81, 82: 2 x status outputs (flow direction, warning, failure, need of maintenance)
- Terminal 33, 34: 1 x MODBUS


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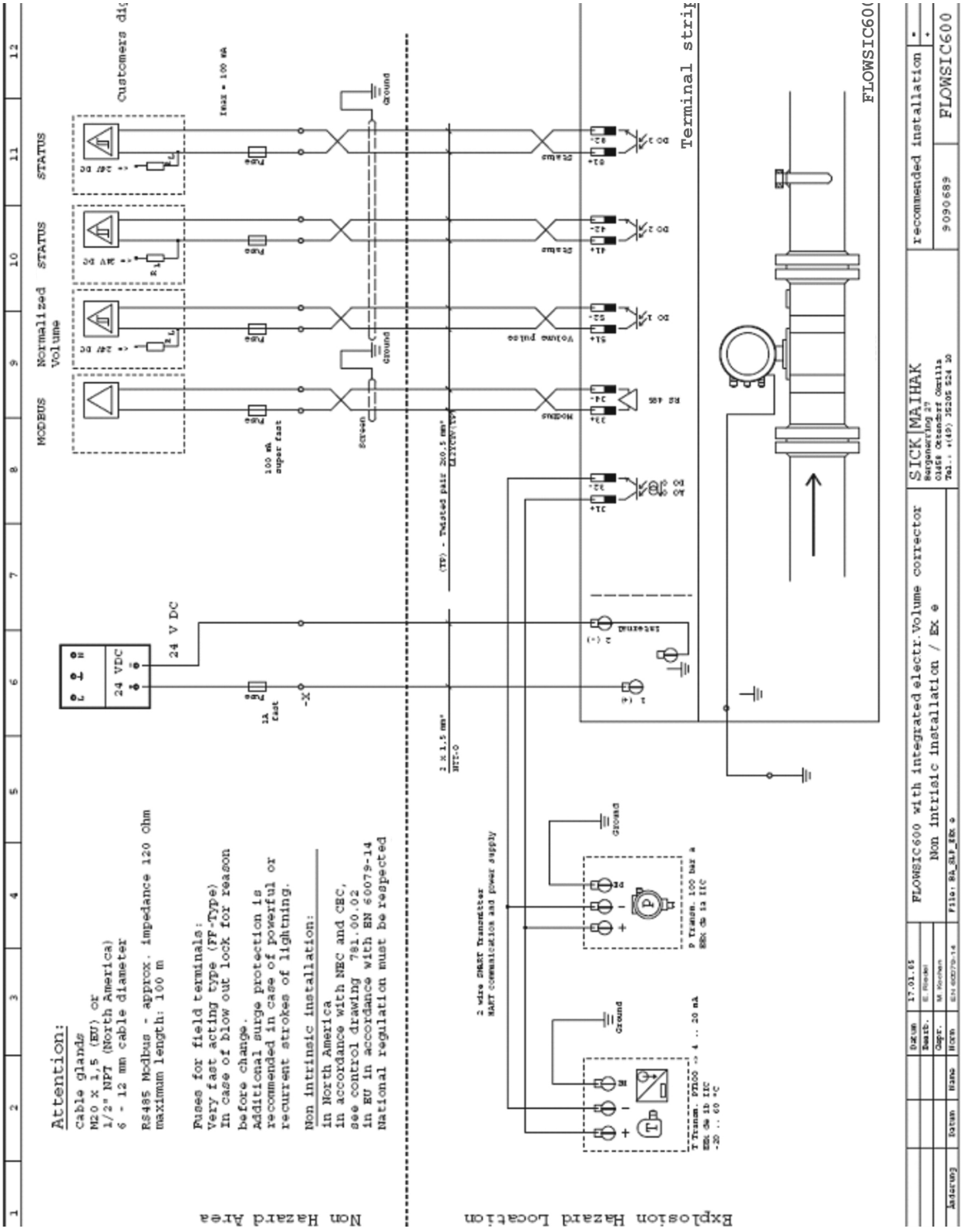


Fig. 2.15: Connection plan FLOWSIC600 with integrated EVC


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# FLOWSIC600

# Ultrasonic Gas Flow Meter

## Installation

General Notes

Installation

Mechanical Installation

Electrical Installation

# 3 Installation

## 3.1 General Notes

### 3.1.1 Delivery

The FLOWSIC600 is delivered in a pre-assembled condition in a sturdy package. The sealing surfaces of the flanges are protected with special caps. When unpacking the device, check for possible damage in transit. Pay particular attention to the interior of the meter body, any visible transducer components and the sealing surfaces of the flanges. Any damage must be documented and reported to the manufacturer immediately.

Also check the consignment for completeness. The standard scope of delivery comprises:

- FLOWSIC600 measuring system (meter body with signal-processing unit and transducers)
- MEPAFLOW600 control and configuration software
- Operating instructions, software manual
- Manufacturer Data Report (MDR)

ATTENTION

**Important**

Make sure the actual site conditions match the information provided on the labels at the meter body and SPU (see **Fig. 3.1**), in order to guarantee a safe and reliable operation of the measuring equipment.

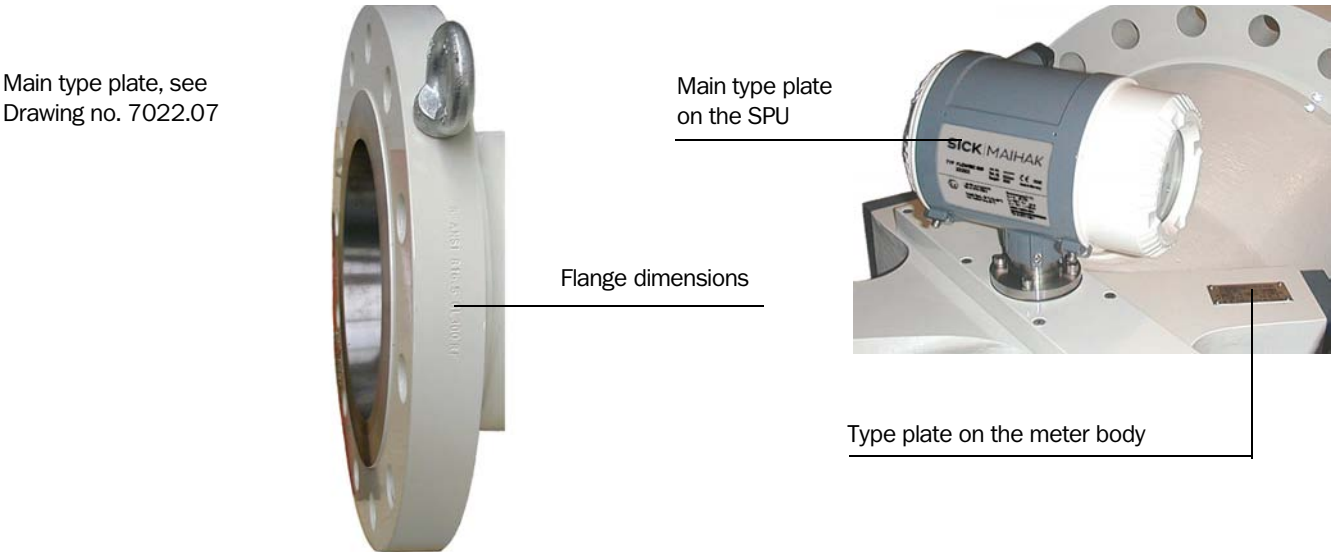
Main type plate, see Drawing no. 7022.07
Flange dimensions
Main type plate on the SPU
SICK MAIHAK
Type plate on the meter body

Fig. 3.1: FLOWSIC600 labels and marks


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### 3.1.2 Transport and storage

ATTENTION

**Important**

Only use lifting gear and load handling equipment (e.g. lifting straps) which are suitable for the weight to be lifted. Max. load information can be found on the type plate of the lifting gear. It is strongly recommended only to use the eye bolts supplied with the device. To lift the FLOWSIC600 please pay attention to **Fig. 3.2**.

During FLOWSIC600 transport and storage operations, make sure that:

- The measuring device is firmly secured at all times
- Measures are taken to avoid mechanical damage
- Humidity and ambient temperature are within specified limits (see Section *2.2.4*).

If the device is to be stored outside for more than one day, sealing surfaces of the flanges and the interior of the meter body must be protected from corrosion, e.g. with Anticorit spray (not required for stainless steel meter bodies). The same measure shall be taken if the device is to be stored in dry condition, but for more than a week.

**Note** Due to natural temperature fluctuation in the course of a day, or if the measuring device is transported to a place with different temperature and humidity, moisture will condense on any material. Carbon steel surfaces may corrode if left unprotected.

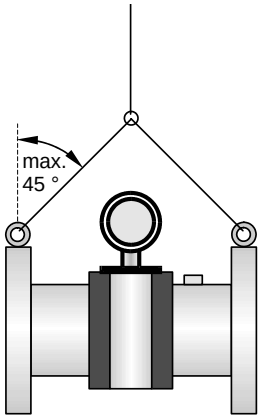


Fig. 3.2: Lifting requirements


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## 3.2 Installation

Generally, the installation arrangement is specified during the project planning phase, before installation of the system. Nominal size, material and type of flange should therefore be in accordance with the design of the existing plant. It is particularly important that the meter body and adjacent pipelines are of identical internal diameter.

Fastening bolts, nuts and flange seals used must be suited to the operational conditions, and comply with legal regulations and relevant standards.

**Note** Any deviation from the planned design of the FLOWSIC600 and installation arrangement shall be agreed with the supplier and documented prior to installing the measuring device.

### 3.2.1 Measuring location

General requirements:

- The FLOWSIC600 can be installed in customary straight inlet and outlet pipes. The adjacent pipes must have the same nominal size as the meter body. The internal diameter can be learned from the marked flange standard (Appendix, Table *9.3*) and the type key information. The max. variation of the internal diameter of the inlet pipe from that of the meter body is 1 %. Any welding beads and rims on the flanges of the inlet pipe shall be levelled or removed.
- The meter body may be installed in horizontal or vertical position. In case of horizontal installation, the meter body shall be aligned such that the planes formed by the measuring paths are in horizontal position. This aims to prevent dirt in the pipeline from entering the transducer ports. Vertical installation is only possible if the measuring system is used for dry, non-condensing gases. The gas flow must be free from any foreign material, dust and liquids. Otherwise, filters and traps shall be used.
- Do not mount installations and fittings which may adversely affect the gas flow directly upstream the FLOWSIC600.
- Seals at the flange connections between meter body and pipeline must not protrude into the pipeline. Otherwise, the flow profile and thus the measuring accuracy may be adversely affected.
- Pressure measuring devices shall be connected to the pressure tap provided (see **Fig. 2.3**). The pressure tap is a 1/4 in NPT (female) port, irrespective of the meter size. The NPS 2 (DN 50) meter forms an exception, its pressure tap is a 1/8 in NPT (female) port.
- Temperature probes shall be arranged as shown in **Fig. 3.3** and **Fig. 3.4**.

### 3.2.2 Installation configurations

The choice of the installation configuration (see **Fig. 3.3** and **Fig. 3.4**) depends on type and extent of the flow disturbance at the installation position (according to TR G13).

| | **Possible installation configuration** |
|---|---|
| None | Configuration 1 or 2 |
| Elbow, reducer | |
| Double elbow out of plane, T piece | |
| Gas pressure controller with/ without muffler | Configuration 2 |
| Diffuser | |
| Diffuser with swirling flow | |

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**Unidirectional use**

**Configuration 1**

**Configuration 2**

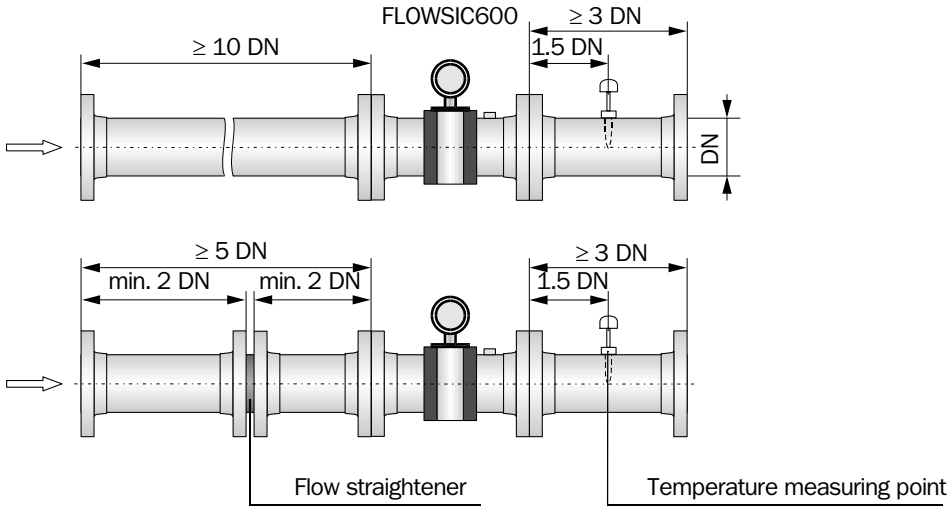


Fig. 3.3: FLOWSIC600 installation in the pipeline for unidirectional use

**Bidirectional use**

Two straight pipes shall be installed in the inlet and outlet sections if the meter is to be used bidirectionally. The temperature measuring point shall be disposed downstream the FLOWSIC600, seen in the direction of predominant use (position 1 or 2 in **Fig. 3.4**).

**Configuration 1**

**Configuration 2**
Not applicable for meters marked with an asterisk (*) in Section *2.2.4*, Table "PTB approve example"

**Configuration 2**
Applicable for meters marked with an asterisk (*) in Section *2.2.4*, Table "PTB approve example"

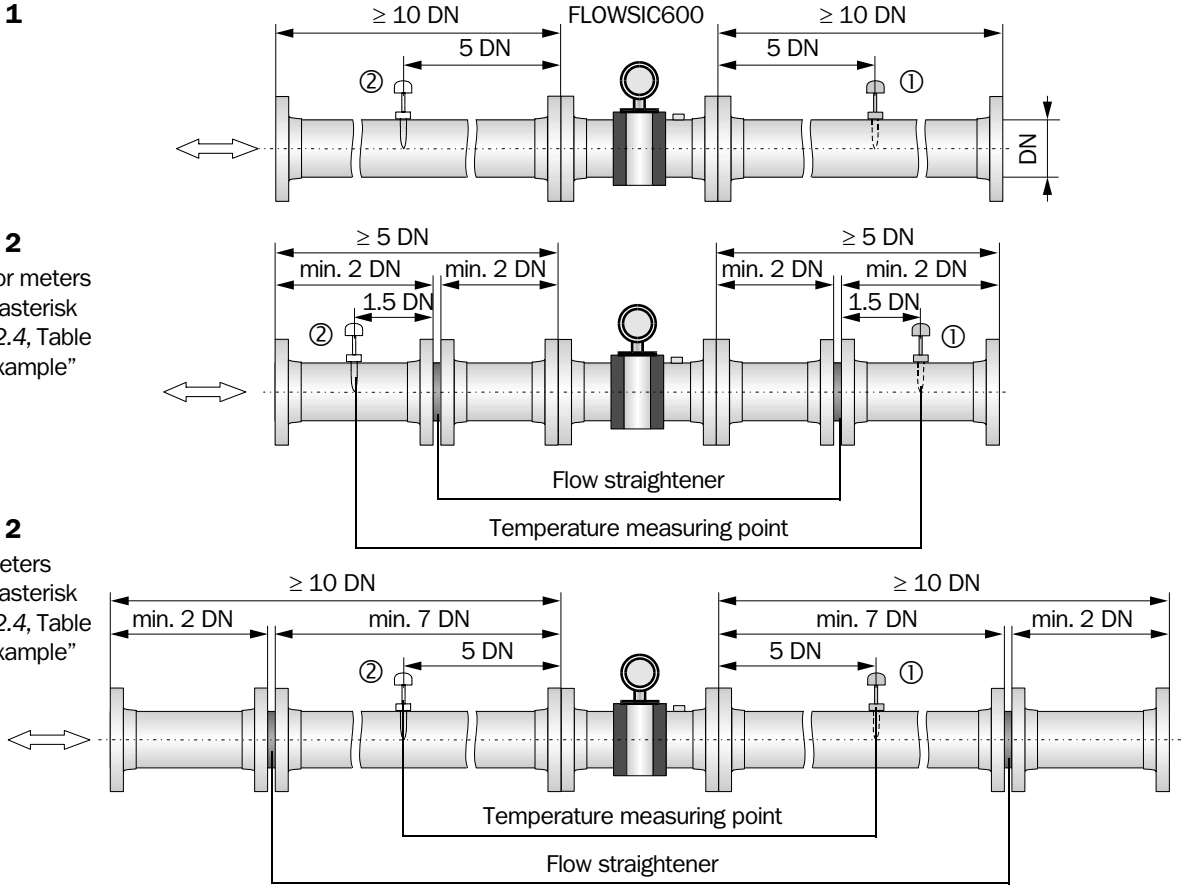


Fig. 3.4: FLOWSIC600 installation in the pipeline for bidirectional use


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## 3.3 Mechanical Installation

Work on the pipelines in preparation to installing the gas flow meter is not included in the scope of delivery.

It is recommended to use the following tools and auxiliaries for correct installation of the FLOWSIC600:

- Lifting gear or fork lift (carrying capacity according to the load information on the type plate)
- Suitable sized ring wrench for flange mounting
- Seal adhesive and separating agents
- Bolt lubricant
- Leak detection spray

DANGER

**Warning**

- Always observe the general safety regulations and safety instructions given in Section 1 when carrying out any installation work.
- The FLOWSIC600 must only be mounted to depressurised and vented pipelines.
- Take all necessary precautions to avoid local or plant-specific dangers.

### 3.3.1 Choosing flanges, seals and other parts

Use pipeline flanges, bolts, nuts, and seals that withstand the maximum operational pressure and temperature, as well as ambient and operational conditions (external and internal corrosion) for the flange connections. For installation lengths and flange dimensions, see Section *9.1*).

DANGER

**Warning**

- Always strictly observe the safety instructions for the installation of pressure equipment including the connection of several pressure components set forth in the Pressure Equipment Directive 97/23/EC.
- Installation staff must be familiar with the directives and standards applicable for pipeline construction.


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### 3.3.2 Mounting the FLOWSIC600 to the pipeline

An arrow on the meter body indicates the main direction of flow. It is recommended to install the FLOWSIC600 as indicated by this arrow if the device is to be used for unidirectional flow applications. If the device is to be used in the bidirectional mode, the arrow indicates the positive direction of flow.

**Installation work to be carried out**

- Position the FLOWSIC600 at the desired place of the pipeline using the lifting gear. Only use the lifting eyes provided to lift and transport the device. If you use lifting straps, wrap them around the meter body.

ATTENTION

**Important**

- The lifting eyes are designed for transporting the measuring device only. Do not lift the FLOWSIC600 using these eyes when additional loads (such as blind covers, filling for pressure tests) are attached (see also Section *3.1.2*)
- Never attach lifting gear to the signal processing unit or its mounting bracket and avoid contact between these parts and the lifting gear.
- The FLOWSIC600 must not turn over or start to swing while being transported. Flange sealing surfaces, SPU housing and transducer cover caps may be damaged when the lifting gear is not attached properly.
- Take suitable measures to prevent damage to the measuring device when carrying out any other work (welding, painting) near the FLOWSIC600.

- Check the correct seat of the flange seals after having inserted the first fastening bolts on both sides.
- Align the FLOWSIC600 such that the offsets between inlet pipe, meter body and outlet pipe becomes as small as possible.
- Insert the remaining fastening bolts and tighten the nuts cross-wise. The tightening torque applied must not be lower than specified in the project planning.
- Mount the pressure line between pressure tap and pressure transmitter.
- Fill the pipeline and check the FLOWSIC600 installed for leaks.

**Note** It is recommended to perform a leak test in accordance with the relevant regulations and standards after completion of the mechanical installation.


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### 3.3.3 SPU alignment

The signal processing unit (SPU) can be turned such that the display can be read easily and that cable routing is facilitated (see **Fig. 3.5**). A stop on the housing prevents the SPU from being turned by more than 330°. This aims to prevent damage to the cables that come from the meter body.

Tool required for loosening and tightening the hexagon socket head screw:

3 mm Allen key

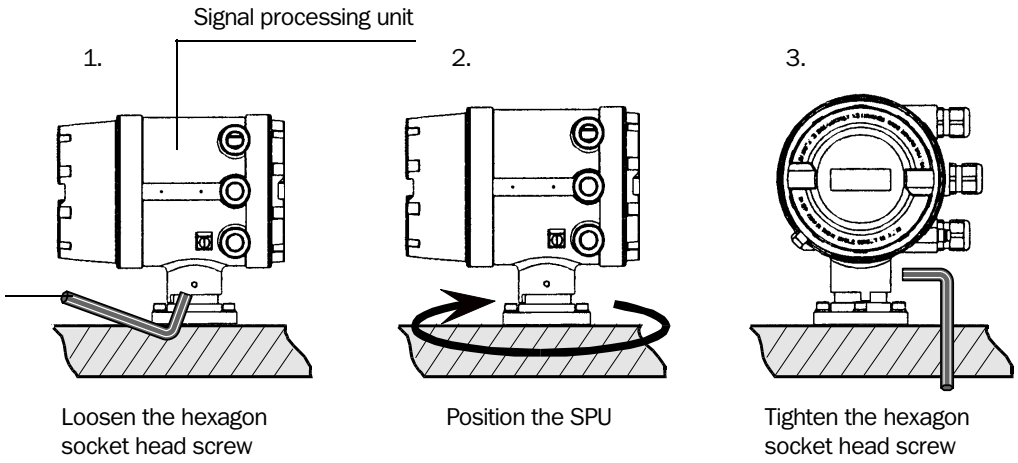


Fig. 3.5: Positioning the SPU

**Note** Do not forget to tighten the hexagon socket head screw after having positioned the SPU.

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## 3.4 Electrical Installation

### 3.4.1 General information

**Pre-requisites**

Wiring work (routing and connecting the power supply and signal cables), which is necessary when installing the FLOWSIC600, is not included in the scope of delivery. The mechanical installation described in Section *3.3* must be completed. Comply with the minimum requirements of the cable specs in accordance with Section *3.4.2*.

**Notes on cable routing**

- Cables shall be laid in conduits or on cable trays to provide protection from mechanical damage.
- Observe the permitted bending radiuses (generally, min. six times the cable diameter for multi-conductor cables).
- Connections outside of conduits shall be as short as possible.

DANGER

**Warning**

- Always observe the general safety regulations and safety instructions given in Section 1 when carrying out any installation work.
- Installation work shall only be carried out by trained staff and in accordance with the relevant regulations issued by the operating company.
- Take all necessary precautions to avoid local or plant-specific dangers.

**General connection of the FLOWSIC600**

Installation examples see Section *9.6*

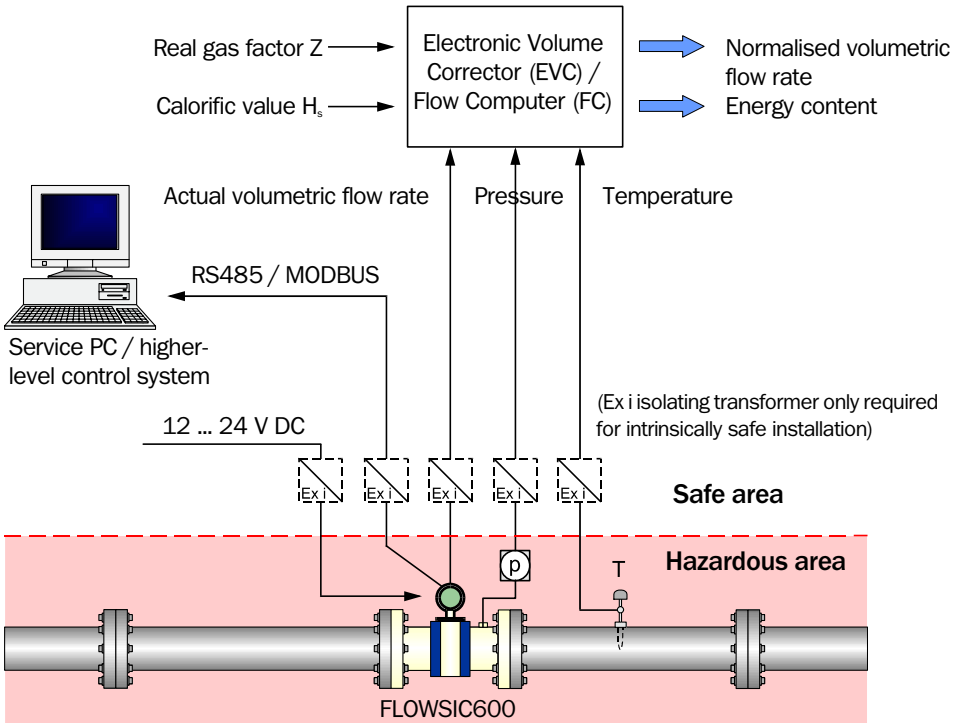


Fig. 3.6: FLOWSIC600 connection diagram


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### 3.4.2 Cable specifications

ATTENTION

**Warning**

The cables must fulfil the requirements for use in hazardous areas (e.g set forth in EN 60079-14 or other relevant standards).

**Power supply 12 … 28.8 V DC**

| | | Notes |
|---|---|---|
| Type of cable | Two conductors | Connect shielding (if present) to ground terminal |
| Min./ max. cross-sectional area | 0.5 mm² / 1.5 mm² | |
| Maximum cable length | Depending on loop resistance; Minimum input voltage on the FLOWSIC600 12 V | Peak current 150 mA |
| Cable diameter | 6 ... 12 mm | Fixing range of the cable glands |

**Digital output / current output**

| | | Notes |
|---|---|---|
| Type of cable | Twisted pair, shielded | Connect shielding at other end to ground terminal |
| Min./ max. cross-sectional area | 2 x 0.5 mm2 | Do not connect unused conductor pairs and prevent them from accidental short-circuit. |
| Maximum cable length | Loop resistance under load ≤ 250 Ω | |
| Cable diameter | 6 ... 12 mm | Fixing range of the cable glands |

**Serial port (RS485)**

| | | Notes |
|---|---|---|
| Type of cable | Twisted pair, shielded, impedance approx. 120Ω | Connect shielding at other end to ground terminal |
| Min./ max. cross-sectional area | 2 x 0.5 mm2 | |
| Maximum cable length | 100 m at 0.5 mm²<br>200 m at 1.5 mm² | Do not connect unused lead pairs and prevent them from accidental short-circuit. |
| Cable diameter | 6 ... 12 mm | Fixing range of the cable glands |


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### 3.4.3 Checking the cable loops

Check the cable loops in order to verify that the cables are connected correctly. Proceed as follows:

- Disconnect both ends of the cable of the loop to be tested.
  This is to prevent connected devices from interfering with the measurement.
- Test the entire cable loop between SPU and terminal device by measuring the loop resistance.
- If you want to test the insulation resistance as well, the cables must be disconnected from the electronic module before using the insulation resistance tester.

**Important**

The test voltage applied would seriously damage the electronic module!

ATTENTION

- Reconnect all cables after the loop resistance test.

**Important**

- In non-intrinsically safe installations, only open the EExe terminal boxes and connect/ disconnect cables if the system is disconnected from the power supply.
- The front cap (with display panel) must only be opened if the system is disconnected from the power supply and only 10 minutes or more after the system has been switched off.
- Incorrect cabling may cause failure of the FLOWSIC600.
  This will cause any warranty claims to expire. The manufacturer excludes any liability for consequential damage.

ATTENTION

### 3.4.4 Terminal box on the SPU

**Opening the rear housing cover**

- Loosen the securing clip using a 3 mm Allen key.
- Turn the rear housing cover counter-clockwise and take it off.

A schematic wiring diagram is provided on the inside of the rear housing cover (see also Appendix, Section *9.3*).

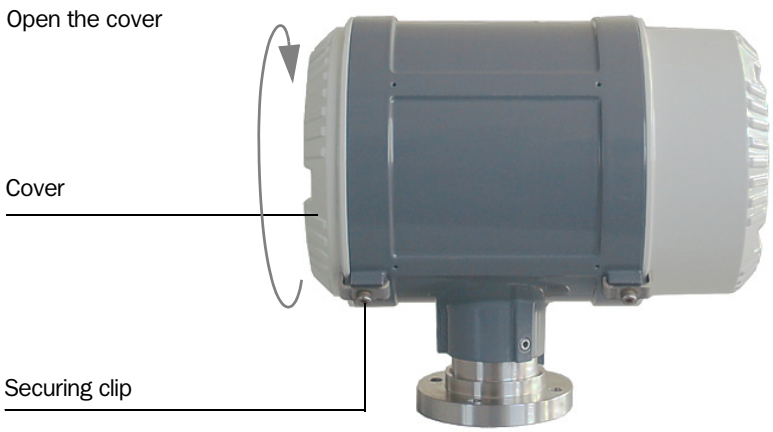


Fig. 3.7: SPU housing


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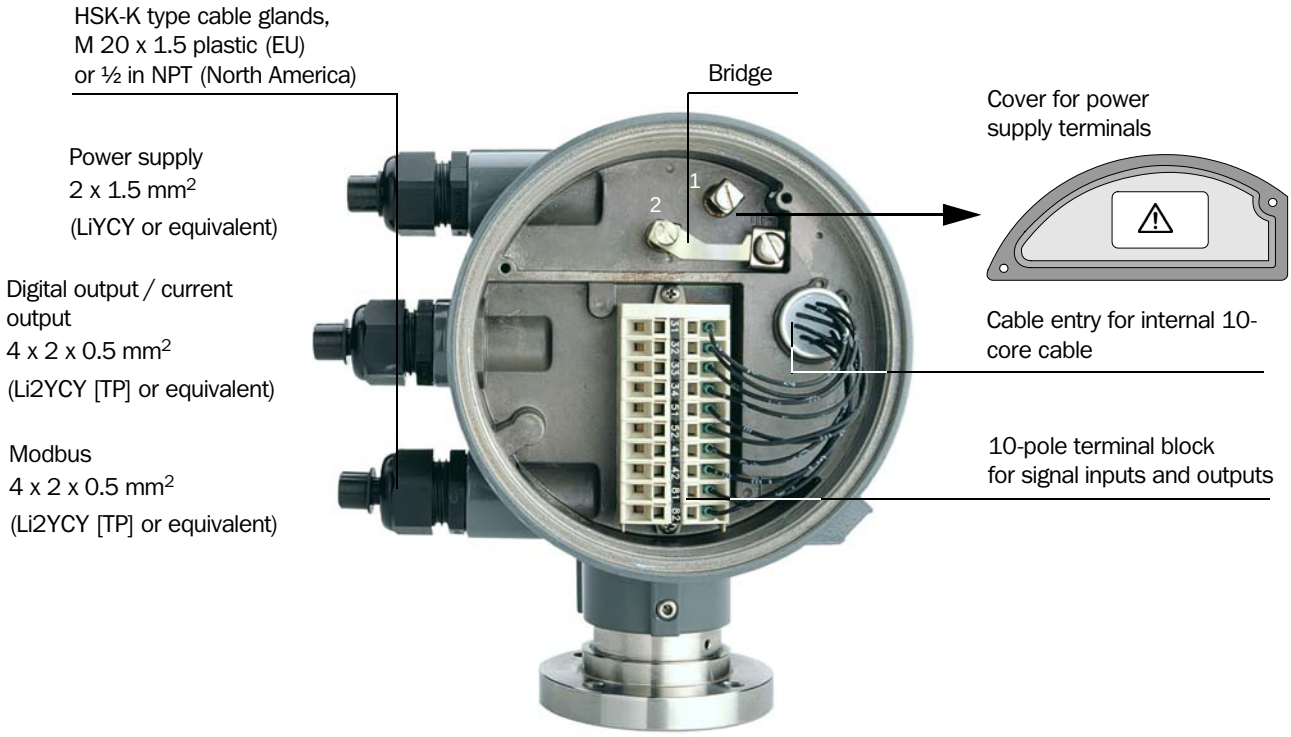
HSK-K type cable glands,
M 20 x 1.5 plastic (EU)
or ½ in NPT (North America)
Power supply
2 x 1.5 mm²
(LiYCY or equivalent)
Digital output / current output
4 x 2 x 0.5 mm²
(Li2YCY [TP] or equivalent)
Modbus
4 x 2 x 0.5 mm²
(Li2YCY [TP] or equivalent)
Bridge
1
2
Cover for power supply terminals
Cable entry for internal 10-core cable
10-pole terminal block for signal inputs and outputs

Fig. 3.8: Terminal box on the rear of the SPU

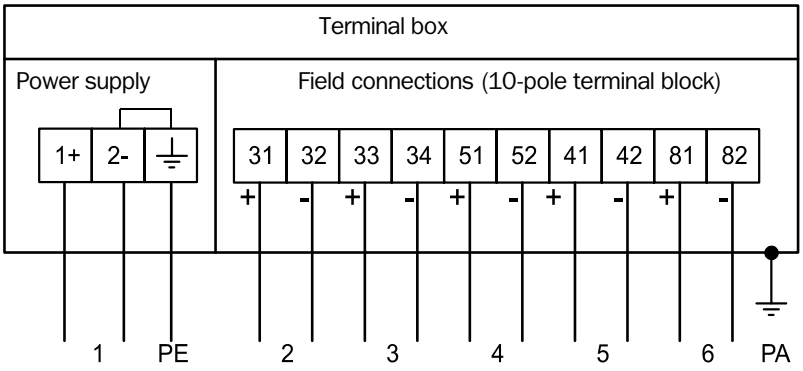


Fig. 3.9: Terminal assignment for use in safe areas

**Note** Terminals 2 and PE are bridged internally, i.e. there is no insulation between PE and negative potential (see **Fig. 3.8**).

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### 3.4.5 Operating the FLOWSIC600 in safe areas

Assign the terminals in the SPU terminal box (see **Fig. 3.9**) in accordance with the following table.

| | Connection for | Function | Terminal | Value | Notes |
|---|---|---|---|---|---|
| 1 | Power supply | | 1+, 2- | 12 ... 24 (+20 %) V DC | |
| 2 | Digital output DO 0 (HF 2) | Passive | 31, 32 | $f_{max}$ = 6 kHz, pulse duration 0.05 s - 1 s<br>Range:<br>Variable number of pulses per volume unit<br>“closed”:<br>0 V ≤ $U_{CE\ L}$ ≤ 2 V, 2 mA ≤ $I_{CE\ L}$ ≤ 20 mA (L=Low)<br>“open”:<br>16 V ≤ $U_{CE\ H}$ ≤ 30 V, 0 mA ≤ $I_{CE\ H}$ ≤ 0.2 mA (H=High) | With NAMUR contact for connection to switching amplifier (to DIN 19234) |
| 3 | Serial port | Modbus (RS485) | 33, 34 | 9600 Baud, 8 data bits, no parity, 1 stop bit | Baud rate to be set through software |
| 4 | Digital output DO 1 (HF 1) | Passive | 51, 52 | $f_{max}$ = 6 kHz, pulse duration 0.05 s - 1 s<br>Range:<br>Variable number of pulses per volume unit<br>“closed”:<br>0 V ≤ $U_{CE\ L}$ ≤ 2 V, 2 mA ≤ $I_{CE\ L}$ ≤ 20 mA (L=Low)<br>“open”:<br>16 V ≤ $U_{CE\ H}$ ≤ 30 V, 0 mA ≤ $I_{CE\ H}$ ≤ 0.2 mA (H=High) | With NAMUR contact for connection to switching amplifier (to DIN 19234) |
| 5 | Digital output DO 2 | Passive | 41, 42 | “closed”:<br>0 V ≤ $U_{CE\ L}$ ≤ 2 V, 2 mA ≤ $I_{CE\ L}$ ≤ 20 mA (L=Low)<br>“open”:<br>16 V ≤ $U_{CE\ H}$ ≤ 30 V, 0 mA ≤ $I_{CE\ H}$ ≤ 0.2 mA (H=High)<br>“Maintenance required” | |
| 6 | Digital output DO 3 | Passive | 81, 82 | “closed”:<br>0 V ≤ $U_{CE\ L}$ ≤ 2 V, 2 mA ≤ $I_{CE\ L}$ ≤ 20 mA (L=Low)<br>“open”:<br>16 V ≤ $U_{CE\ H}$ ≤ 30 V, 0 mA ≤ $I_{CE\ H}$ ≤ 0.2 mA (H=High)<br>“Direction of flow”<br>(alternative “Warning”) | |
| | Alternative assignment with second serial port (RS485) | | | 9600 Baud, 8 data bits, no parity, 1 stop bit | Baud rate to be set through software |


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### 3.4.6 Operation in hazardous areas in accordance with Directive 94/9/EC (ATEX)

The power supply and field connections are designed with the increased type of protection ("e"). The transducer connections are of an intrinsically safe design ("ia").

All screw-type terminals as well as air gaps and creepage distances of the FLOWSIC600 comply with EN 50019.

#### Connection characteristics

| | **Field connections** |
|---|---|
| Separate terminal box, separated from the field connections with partition wall in the housing and cover to EN 50020. | Separate terminal box, separated from the power supply connections with partition wall in the housing and cover to EN 50020. |
| Cable routing via EExe cable gland, M5 ground terminal integrated into housing section (cast-on part). | Cable routing via 2x EExe cable gland |

#### Connection options

The protection concept for the FLOWSIC600 permits the following connection options:

- Power supply connection and field connections with increased type of protection ("e")
- Intrinsically safe power supply connection and field connections ("i")
- Power supply connection with increased type of protection ("e"), while the field connections are intrinsically safe ("i")

The user shall decide which option is to be used, taking into account EN 60079-14.

A combination of intrinsically safe and non-intrinsically safe circuits is not permitted in the terminal box for the field connections.

The rated voltage of non-intrinsically safe circuits is $U_M = 253$ V.

#### Requirements regarding cabling in hazardous areas (Europe)

- The cables must fulfil the requirements set forth in EN 60079-14.
- Cables that are subject to exceptional thermal, mechanical, or chemical loads must be specially protected (e.g. laid in open-ended conduits).
- Cables that are not fire proof must demonstrate fire resistance according to DIN VDE 0472, Part 804, test type B.
- Attach ferrules to the wire ends to ensure that they do not split up.
- The applicable requirements regarding air gaps and creepage distances must be observed in accordance with EN 50019. The available air gaps and creepage distances in the terminal box must not be reduced when connecting the cables.
- Unused cable glands must be replaced by the EExe plugs included in the delivery.
- The equipotential bonding must be in accordance with EN 60079-14.
  The meter body and SPU housing must be connected to the potential equalizer. In intrinsically safe circuits, provide equipotential boding along the wiring runs of the current outputs.
- The applicable national specifications shall also be observed.


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**Terminal assignment**

The terminal assignment in the SPU terminal box (see **Fig. 3.9**) is the same as for the installation of the FLOWSIC600 in non-hazardous areas (see table in Section *3.4.5*).

ATTENTION

**Important**

The protective conductor must not be connected within the hazardous area. For measurement reasons, the equipotential bonding must, as far as possible, be identical to the pipeline potential. Additional grounding with the protective conductor PE via the terminals is not permitted!

**Notes for safe operation in hazardous areas**

Approval of the ultrasonic transducers in zone 0 only valid for operation under atmospheric conditions.

- Type of explosion protection: II 1/2G EEx de ib [ia] IIC T4 or II 2G EEx de ib [ia] IIA T4
- Ambient temperature: -20°C to +60°C
  In the extended temperature range from -40 C to +60 C, metal cable glands shall be used only.
- The cable glands included in the delivery are black. If terminals are assigned with intrinsically safe circuits, it is recommended to replace the black ones with the light-blue (RAL 5015) cable glands provided.
- For the temperature class according to the ambient temperature and gas temperature, see the EC Type Approval Certificate.
- The type of protection for the field connections and power supply connection is determined by the external circuits that are connected (for options see "Connection options" above).
- Safety-relevant data for intrinsically safe circuits is provided in the EC Type Approval Certificate.
- Ensure that the cover on the power supply connection is properly sealed. In intrinsically safe installations, the terminal box can be opened and cables connected and disconnected while the system is live.
- If the meter body is insulated, the insulation thickness must not exceed 100 mm. The SPU housing must not be insulated.

ATTENTION

**Important**

Always observe the temperature specifications for use in hazardous areas.


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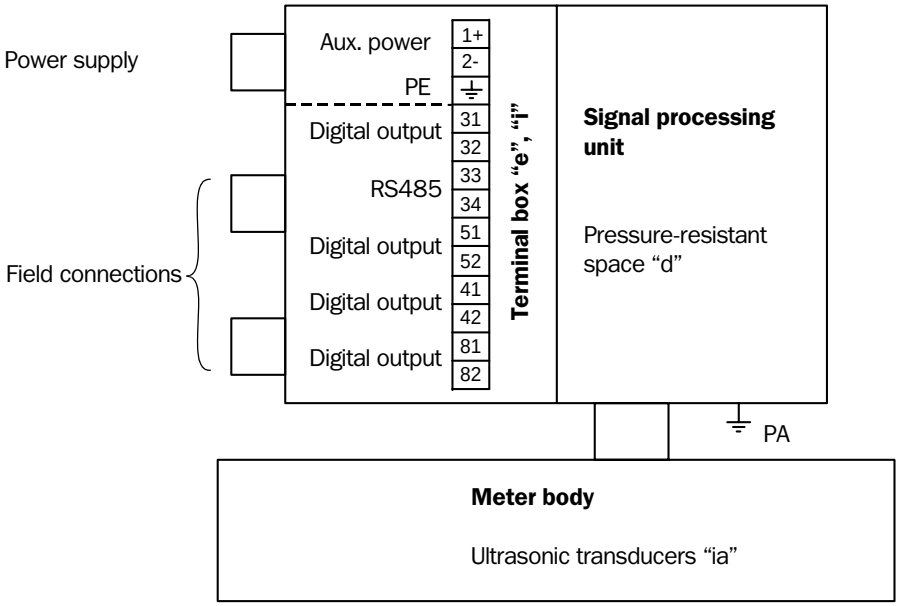


Fig. 3.10: FLOWIC600 components and their type of protection

### Safety-relevant data of inputs and outputs

<table>
<tr><td>Output circuit</td><td colspan="5">Intrinsically safe EEx ia IIA / IIC</td><td>Non-intrinsically safe<br>$U_M = 253$ V</td></tr>
<tr><td rowspan="4">Active current output<br>Terminals 31/32</td><td colspan="5">$U_O = 22.1$V</td><td rowspan="4">$U_B = 18$ V<br>$I_B = 35$ mA</td></tr>
<tr><td rowspan="2">$I_O$ [mA]</td><td rowspan="2">$P_O$ [mW]</td><td colspan="2">EEx ia IIA</td><td colspan="2">EEx ia IIC</td></tr>
<tr><td>$C_O$ [nF]</td><td>$L_O$ [mH]</td><td>$C_O$ [nF]</td><td>$L_O$ [mH]</td></tr>
<tr><td>155 / 155</td><td>857 / 857</td><td>4100</td><td>7</td><td>163</td><td>1</td></tr>
<tr><td colspan="6">Characteristic curve: linear<br>Internal capacity $C_I = 4$ nF, internal inductance $L_I = 0.075$ mH<br>Only for connection to passive, intrinsically safe circuits or intrinsically safe circuits with the following maximum values: $V_I = 30$ V</td></tr>
<tr><td>Passive current output<br>Terminals 31/32</td><td colspan="3">$U_I = 30$ V<br>$I_I = 100$ mA<br>$P_I = 750$ mW</td><td colspan="2">$C_I = 4$ nF<br>$L_I = 0.075$ mH</td><td>$U_B = 30$ V<br>$I_B = 35$ mA</td></tr>
<tr><td>Digital output<br>Terminals 31/32, 51/52, 41/42, 81/82</td><td colspan="3">$U_I = 30$ V<br>$I_I = 100$ mA<br>$P_I = 750$ mW</td><td colspan="2">$C_I = 4$ nF<br>$L_I = 0.075$ mH</td><td>$U_B = 30$ V<br>$I_B = 100$ mA</td></tr>
<tr><td>RS485<br>Terminals 33/34 and 81/82</td><td colspan="3">Characteristic curve: linear<br>Uo = 5.88 V<br>Io = 313 mA<br>Po = 460 mW<br>Co = 1000 • F/43 • F<br>Lo = 1.5/0.2 mH</td><td colspan="2">Ui = 10 V<br>Ii = 275 mA<br>Pi = 1420 mW</td><td>$U_B = 5$V<br>$I_B = 175$ mA</td></tr>
<tr><td rowspan="2">Ultrasonic transducer connections<br>(for connecting SICK | MAIHAK ultrasonic transducers only)</td><td colspan="3">EEx ia IIA</td><td colspan="2">EEx ia IIC</td><td></td></tr>
<tr><td colspan="3">Characteristic curve: linear<br>Max. transmission voltage Uo = 60.8 V<br>Short-circuit current Io = 95 mA<br>Po = 1444 mW<br>Co = 300 nF</td><td colspan="2">Uo = 38.9 V<br>Io = 60 mA<br>Po = 584 mW<br>Co = 34 nF</td><td></td></tr>
</table>

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### 3.4.7 Hardware signal settings

The output assignment is determined by jumpers on the backplane in the signal-processing unit. If the assignment is specified by the order, the jumpers are set accordingly before delivery (for details see the service manual).

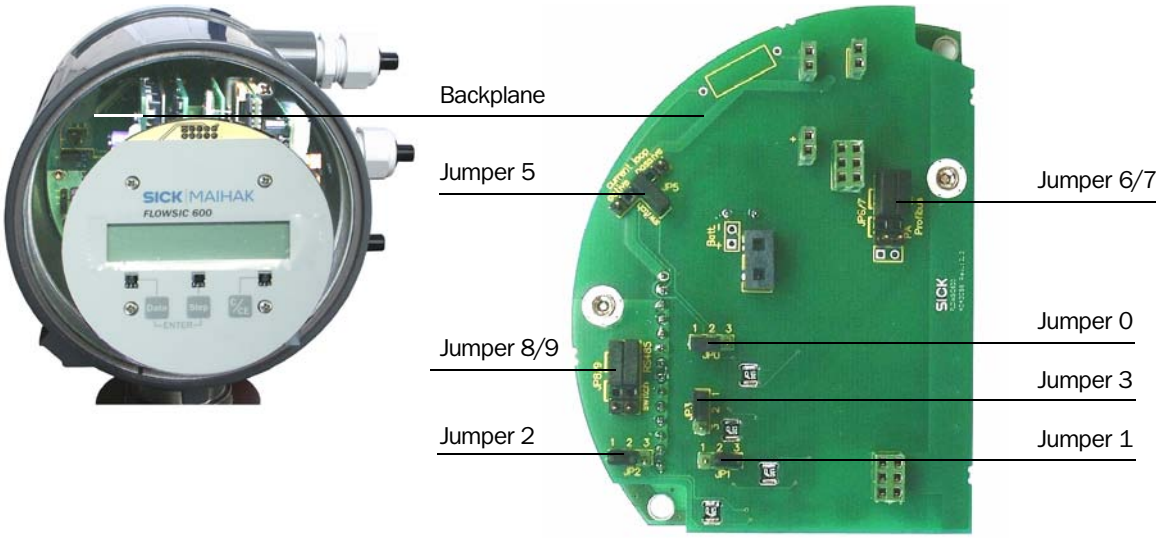


Fig. 3.11: Backplane with jumpers in the SPU

**Jumper setting – Output assignment**

| No. | Setting | No. | Setting | Output | Assignment: Hardware variant 1 | Assignment: Hardware variant 2 | Terminals |
|---|---|---|---|---|---|---|---|
| 5 | Active | | | AO 0 | - | Measured value (Signal current 4 … 20 mA) | 31, 32 |
| | Passive | | | | | | |
| | Switch | 0 | 1 2 3 Open Collector | DO 0 | Measured value (frequency signal), inverse value of DO 1, constantly “open” in case of a malfunction | - | |
| | | | 1 2 3 NAMUR | | | | |
| 1 | 1 2 3 Open Collector | | | DO 1 | Measured value (frequency signal) | • Measured value (frequency signal)<br>• Direction of flow<br>• Malfunction<br>• Maintenance required<br>• Warning | 51, 52 |
| | 1 2 3 NAMUR | | | | | | |
| 2 | 1 2 3 Open Collector | | | DO 2 | Maintenance required | • Direction of flow<br>• Malfunction<br>• Maintenance required<br>• Warning | 41, 42 |
| | 1 2 3 NAMUR | | | | | | |
| 8/9 | Switch | 3 | 1 2 3 Open Collector | DO 3 | • Direction of flow<br>• Warning | | 81, 82 |
| | | | 1 2 3 NAMUR | | | | |
| | RS485 | | | UART RS485 | | | |
| 6/7 | PA | | | Prepared for Profibus RPA* | | | 33, 34 |
| | DP | | | RS485 (or Profibus DP *) | | | |


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* Not yet available

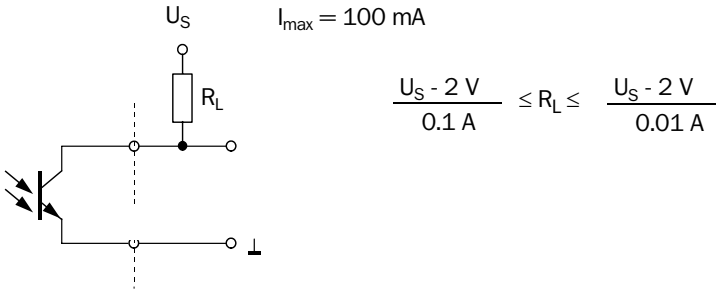
Signals are assigned by the MEPAFLOW600 program (see software manual).

**Wiring of digital outputs**

The digital output (terminals 31/32, 51/52, 41/42, 81/82) can be wired as Open Collector or as NAMUR contact for connection to a NAMUR amplifier.

The outputs are wired to “NAMUR” on delivery, unless “Open Collector” was specified in the purchase order.

Open Collector




NAMUR

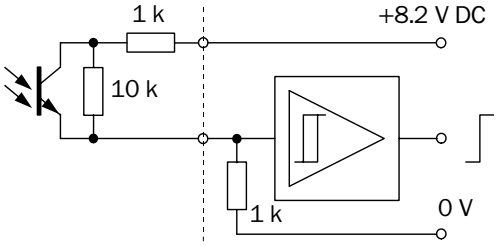



Fig. 3.12: Wiring of digital outputs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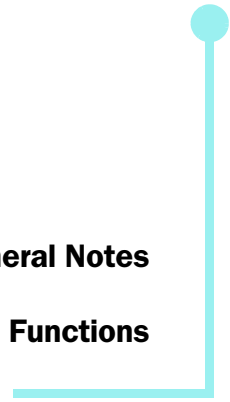
# FLOWSIC600

# Ultrasonic Gas Flow Meter

## Commissioning



General Notes

Checking the Functions

# 4 Commissioning

## 4.1 General Notes

Before starting commissioning, all activities that are described in Chapter 3 have to be completed. We recommend to use a laptop/PC with installed MEPAFLOW 600 program for the commissioning (for installation instructions, see the software manual).

The FLOWSIC600 is 'wet' or 'dry' calibrated when delivered to the end user. The 'dry' calibration contains the 3-D measurement of the meter body, zeroflow and velocity of sound test, and other system specific examinations which belong to the manufacturing and quality insurance process. The 'wet' calibration is performed at a flow calibration test stand.

All parameters, determined by the mentioned tests, as well as custom-designed data are preset and stored in the FLOWSIC600 in a non-volatile memory before delivery. Custom-designed data that are known before manufacturing the device don't have to be changed during commissioning. It's important to know this especially in cases when the FLOWSIC600 is officially sealed after an authorized flow calibration. Generally the parameters are protected by a password. If the FLOWSIC600 shall be used for custody transfer applications, each changes of parameters and configuration protection switch have to be agreed with the national authorities. In all other cases the output parameters of the FLOWSIC600 can be adapted at site by trained staff.

Commissioning the FLOWSIC 600 involves the following steps, no matter whether the device is installed at a test stand or at the final measuring location:

- Checking the functions
- Adjusting the output signals
- Data recording.

**Checking identifications, operation and design data**

see the software manual

Before starting the commissioning, cross-check the data of the present flow meter with the data of the test protocols which are contained in the Manufacturers Data Report (MDR). You can do this by using the LCD (if available; see Section *9.2*) or in a easier way by using the MEPAFLOW600 software. To do so, open the ''Device diagnosis'' tab and compare the data in the ''Device identification'' field (see **Fig. 4.1**) with the data in the check reports of the MDR (see Section *9.5.3* and *9.5.4*) or, when the meter is calibrated, with the configuration protocol of the calibration report.

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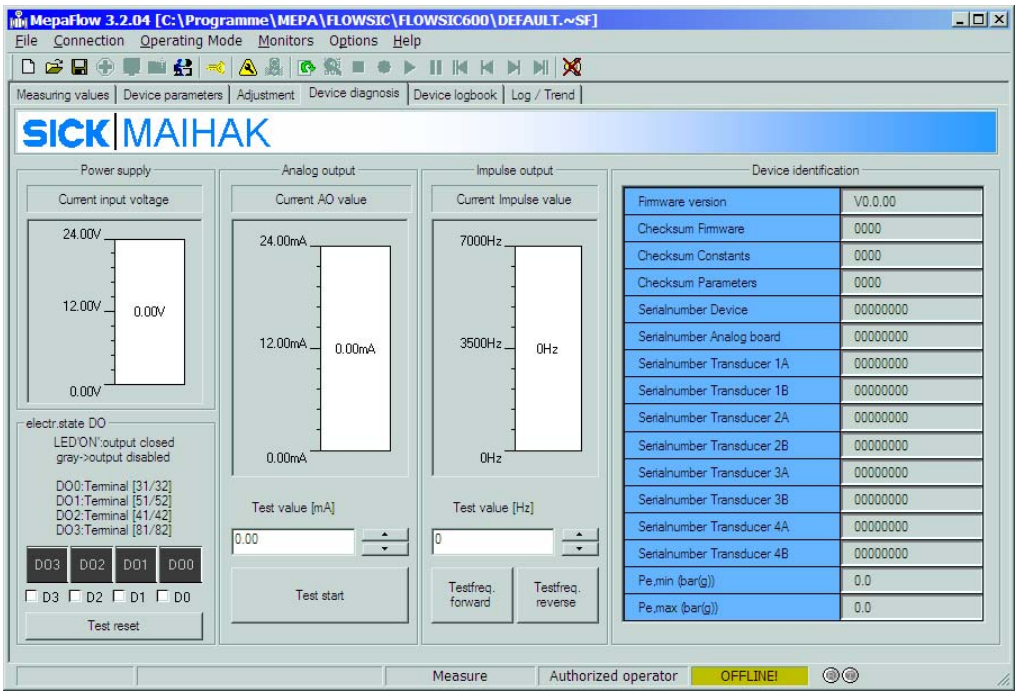


Fig. 4.1: 'Device diagnosis' tab

### Firmware

The FLOWSIC600 firmware is stored on a FLASH PROM. The program code for the signal processor and system micro-controler is identified by a version number (register#5002) and a check sum (register #5005) and can be verified as mentioned above. In case of using the FLOWSIC600 for fiscal metering, the approved firmware versions and the associated check sums are documented in the national pattern approval certificates.


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## 4.2 Checking the Functions

### 4.2.1 FLOWSIC 600 with LED Front Panel

The FLOWSIC 600 is functioning correctly when the green status LEDs for each measuring path installed start flashing periodically approx. 30 s after the power supply is switched on.

If the yellow LED flashes, the FLOWSIC600 works in the operation mode ”Maintenance required” with an insignificantly reduced accuracy (e.g. if one path fails).

If the yellow LED lights up permanently, the measurement is invalid. In this case, you must diagnose the error (see Chapter 7).

### 4.2.2 FLOWSIC 600 with LCD Front Panel

The FLOWSIC 600 is functioning correctly if the values are displayed consecutively for 5 s each. If measured values are flashing, the FLOWSIC600 works in the ”Maintenance required” mode.

If an error is present, the LCD flashes. As soon as the cause of the error has been rectified, the FLOWSIC600 automatically returns to the measured value display. As soon as the system identifies an error, the letter "E" (error) or "W" (warning) flashes on the right-hand side of the line at the top of the LCD. This continues to be displayed after the error has been rectified, thereby enabling fleeting errors to be indicated. Detailed information on errors is available in the logbook (see the software manual or Section 9.2). The flashing letter disappears once you have acknowledged this message in the logbook.

You can determine the cause of the error by diagnosing it (see Chapter 7).

**Note** You are advised to check the plausibility of the measured and diagnosis values, even if the device is functioning properly (see Chapter 6).

### 4.2.3 Function test

The major system parameters are configured at the factory. The default settings should allow error-free operation of the ultrasonic gas flow meter.

There are two possibilities for testing the functions:

- **Test without PC and MEPAFLOW600 software**
  The information listed below is shown directly on the LC display of the FLOWSIC600 (for details on the menu structure and operation with a magnetic pen, see Section 9.2).
- **Test with PC and MEPAFLOW600 software**
  Connect the serial port of the FLOWSIC600 with the USB port of a PC and start the MEPAFLOW600 program (see the software manual Chapter 2).

The following description relates to the function test using a PC and the MEPAFLOW600 software.

After having linked PC and FLOWSIC600, run the MEPAFLOW600 program and call up the “**Connection**” menu.

Specify an available PC port (COM1, COM2) in the “Connection” box and enter the password “SICKOPTIC” by activating the “Authorised operator” box (see **Fig. 4.2**). The default device address is 1.

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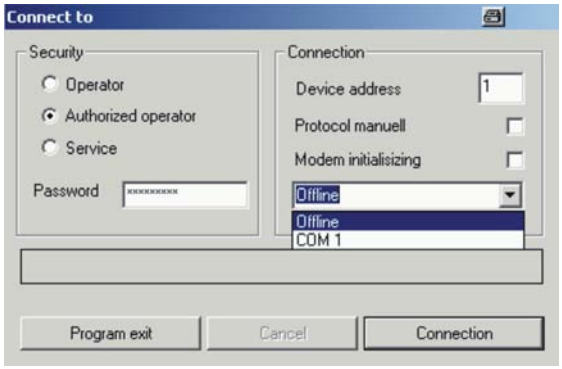


Fig. 4.2: MEPAFLOW600 “Connect to” menu

**Note** If you cannot get connected with the FLOWSIC600, refer to the software manual for details on troubleshooting.

If you are connected successfully, the current measured values, counter readings and system status information will be displayed as shown in **Fig. 4.3**.

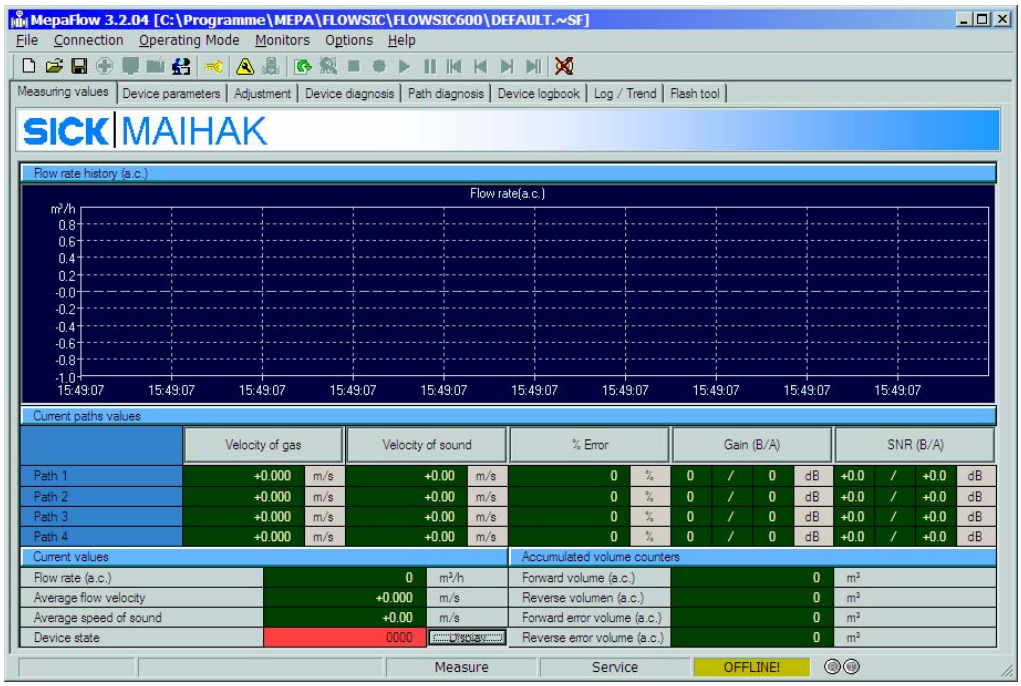


Fig. 4.3: “Measured values” tab

The values for validation rate (“% invalide measurements”), velocities of sound and more are be displayed in the **“Monitors”** menu (see **Fig. 4.4** to **Fig. 4.7**).

**Note** The validation rate is the ratio of rejected measurements and total measurements. It is an indicator for the quality of the measurement in the ultrasonic measurement path.


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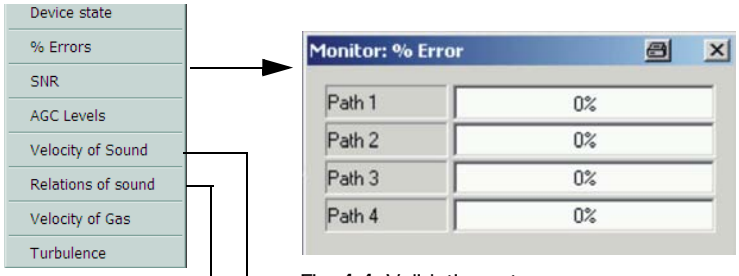


Fig. 4.4: Validation rate

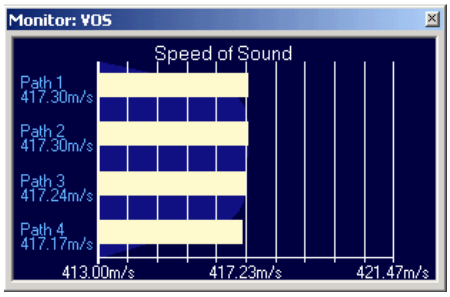


Fig. 4.5: Absolute sound velocity in the individual paths

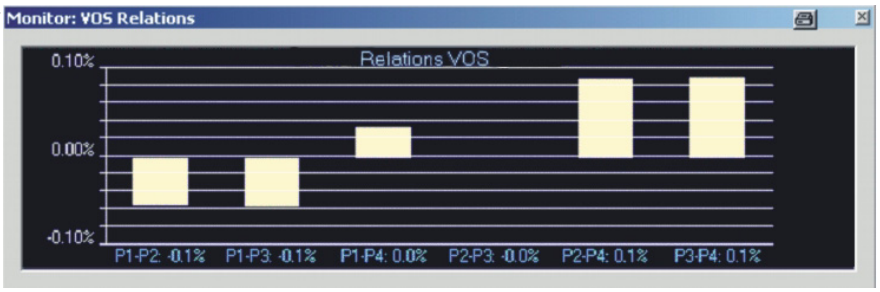


Fig. 4.6: Relative variation of the sound velocity among the individual paths

### Test criteria

- The proportion of invalid measurements at a max. operating volumetric flow should be less than 25 %. Call up the “Devive state” sub-menu in the “Monitors” menu in order to find the cause for the error. The status indicators of the measuring paths (P1 to P4) show the most frequent cause of errors for each path.
  If Bit 13 “Time plausibility” is active (see **Fig. 4.7**), the zero phase position must be optimised (details on the procedure can be found in the FLOWSIC600 service manual).

If the zero phase parameters are optimised properly, these parameter modifications do not trigger any reaction, so that they do not affect the measuring value.

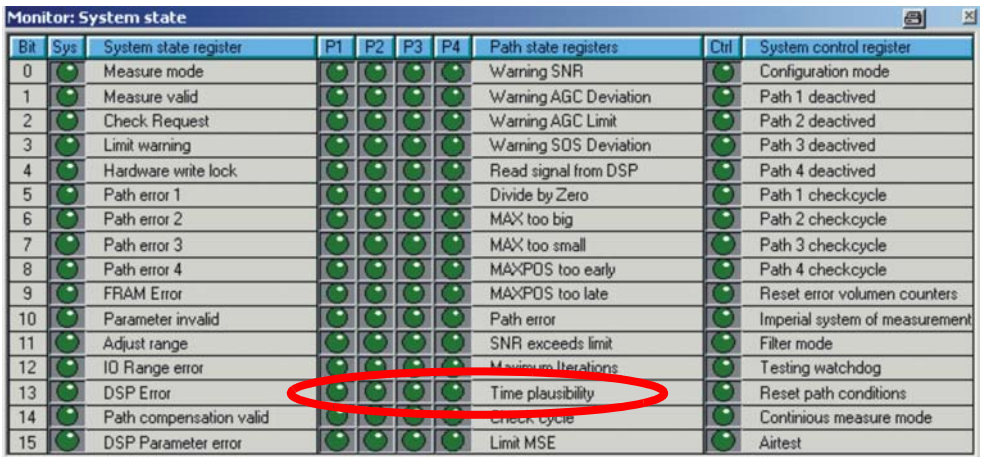
Monitor: System state
Bit Sys System state register P1 P2 P3 P4 Path state registers Ctrl System control register
0 Measure mode Warning SNR Configuration mode
1 Measure valid Warning AGC Deviation Path 1 deactived
2 Check Request Warning AGC Limit Path 2 deactived
3 Limit warning Warning SOS Deviation Path 3 deactived
4 Hardware write lock Read signal from DSP Path 4 deactived
5 Path error 1 Divide by Zero Path 1 checkcycle
6 Path error 2 MAX too big Path 2 checkcycle
7 Path error 3 MAX too small Path 3 checkcycle
8 Path error 4 MAXPOS too early Path 4 checkcycle
9 FRAM Error MAXPOS too late Reset error volumen counters
10 Parameter invalid Path error Imperial system of measurement
11 Adjust range SNR exceeds limit Filter mode
12 IO Range error Testing watchdog
13 DSP Error Time plausibility Reset path conditions
14 Path compensation valid Continious measure mode
15 DSP Parameter error Limit MSE Airtest

Fig. 4.7: ”Device status” sub-menu

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- The relative variation of the sound velocities in the individual measuring paths should not exceed ±0.1 %.

**Note** In case of a very low flow velocity, there may be substantial variation among the measurement paths due to thermal stratification.

- The absolute variation between the measured sound velocity and theoretical sound velocity (calculated on the basis of the gas composition) should not exceed ±0.3 %.

### 4.2.4 Checking the adjust factor, meter factor and analog output

An overview of these parameters is provided on the **"Device parameters"** tab in the MEPAFLOW600 program (password level 'Authorised operator', password 'sickoptic'; see **Fig. 4.8**).

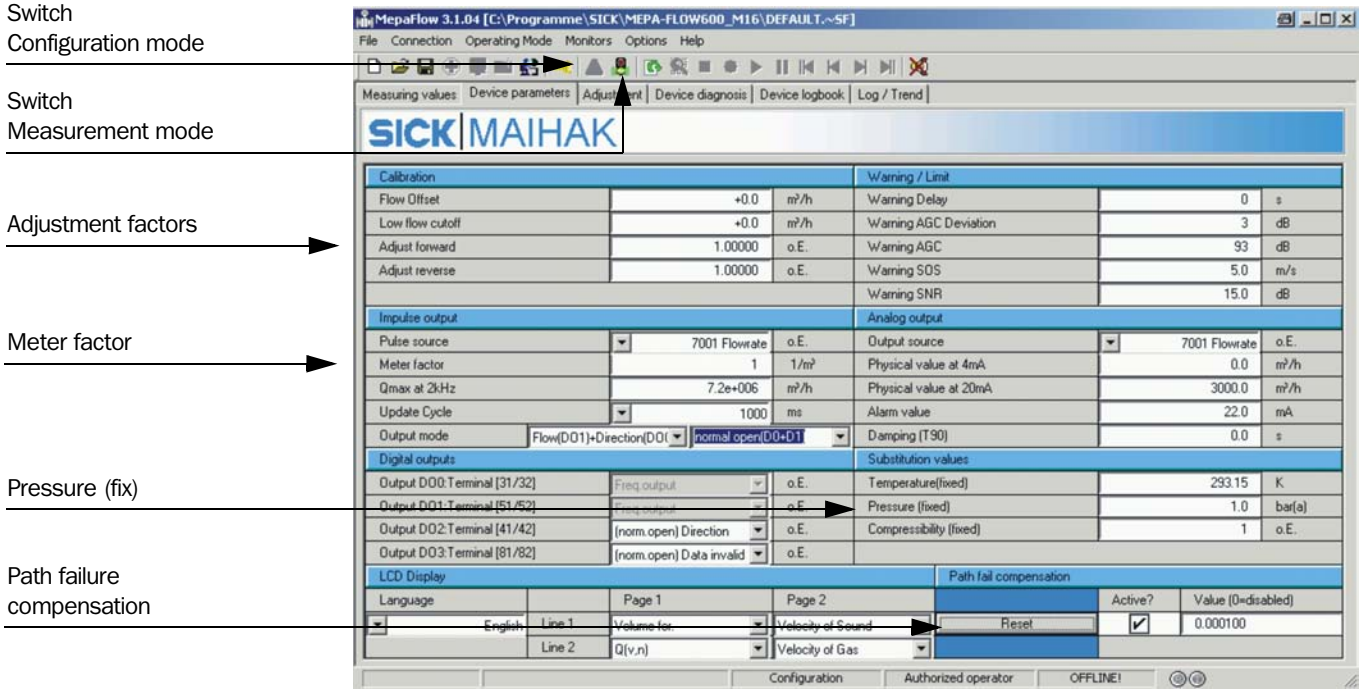


Fig. 4.8: "Device parameters" tab

#### Adjust factors

Reading on the LC display in the "Register" menu

For each direction of flow (forward and reverse) exists one adjustment factor (registers #7037 and #7038). Both have to be checked by using the configuration protocol to secure correct measurements. If the meter is not yet flow calibrated, the adjust factor must be 1. If the meter is calibrated, this factors must correspond to the values in the flow calibration protocol.

#### Meter factor

Reading on the LC display in the "Pulse output" menu

The meter factor specified on the main type plate must be identical to the software parameter value (register #7027). The meter factor is set at the factory according to the customers statement. If this doen't exists, the meter factor is set to a standard value such that the maximum pulse output frequency is approx. 2 kHz at the maximum flow rate (see Section *2.2.4*).

**Note** Any changes of the meter factor during commissioning in case of required adaption to the current application and using the meter for fiscal purposes have to be agreed with the authorities. In addition, in such cases the main type plate has to be exchanged with a new one that contains the new factor.


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The new meter factor can be calculated by using the following formula.

$$\text{Meter factor} = \frac{f_{max} \bullet 3600}{Q_{max}} \qquad \left[\frac{\text{Pulse}}{\text{Volume unit}}\right]$$

$f_{max}$ : max. pulse frequency[Hz]

$Q_{max}$ : max. volumetric flow [m³/h], [ft³/h]

### Analog output

To adapt the FLOWSIC 600 at the different application conditions, you have to adjust the analog output using the MEPAFLOW600 software (field 'Analog output' in the 'Device parameters' tab, see the software manual). The output current $I_{out}$ is calculated as follows:

$$I_{out} = 4\ mA + \frac{Q - AORangeLow}{(AORangeHigh - AORangeLow)} \bullet 16\ mA$$

| | |
|---|---|
| Q: | Actual volumetric flow rate, normalised volumetric flow rate, mass flow rate, melecular weight |
| AORangeHigh: | Upper range limit (has to be set) |
| AORangeLow: | Lower range limit (has to be set) |

**Note** If components that may affect the flow profile (e.g. valves) are installed in the pipe at a distance of less than 20 DN upstream, the adaptive path failure compensation routine must be deactivated (see Section 2.8 and **Fig. 4.8** "Path fail compensation' box .

### Sealing

After having completed the electrical installation, seal the signal processing unit in accordance with the sealing plan (see Section 9.7).

Fasten the magnetic pen, which is part of the measuring system and which is used to operate the LC display on the signal processing unit, to the FLOWSIC600 using the straps provided so that it cannot be lost.

### Data back-up

As a final step of the commissioning procedure, generate a diagnosis and status log using the MEPAFLOW600 software (see the software manual). You can use this information for comparing during subsequent testing.

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# FLOWSIC600

# Ultrasonic Gas Flow Meter

## Calibration

General Notes

Preparation

Calibrating the FLOWSIC600

# 5 Calibration

This chapter is a summary of all information about calibrating the FLOWSIC600 that are contained in different parts and documents. It can also be used as a single document to support the staff of flow test stands when calibrating the meter.

The information below relates to FLOWSIC600 devices marked 'II$^+$' and the MEPAFLOW600 programme version 3.x.xx.

## 5.1 General Notes

The FLOWSIC600 can be calibrated at a certified flow test stand to reduce the measurement uncertainty and to relate it to the national standards.

The following conditions must be fulfilled before the FLOWSIC600 can be calibrated:

- To use a FLOWSIC600 in fiscal metering applications, a national pattern approval certificate must exist. The requirements of the pattern approval documents have to be covered by this FLOWSIC600.
- The meter body must be approved for the maximum gas pressure that is applied.
- The FLOWSIC600 must be installed according to Chapter 3.
- The FLOWSIC600 must be commissioned according to Chapter 4.

### 5.1.1 Definition of test points (test flow rates)

Flow rate calibration aims to find the deviation of the meter under test from a standard or norm. It is conducted on flow rate test bench. Number and position of test points are defined in the literature, but may alternatively be defined individually by the customer.

| | | | | | |
|---|---|---|---|---|---|
| **Measuring range (turn down)** | | | | | |
| | **1:20** | **1:30** | **1:50** | **> 1:50** | |
| - | - | - | - | $Q_{min}$ | $Q_{min}$ |
| - | - | - | 2 % | - | - |
| - | - | 3 % | - | 3 % | - |
| - | 5 % | 5 % | 5 % | 5 % | - |
| 10 % | 10 % | 10 % | - | - | 10 % |
| - | - | - | 15 % | 15 % | - |
| 25 % | 25 % | 25 % | 25 % | 25 % | 25 % |
| 40 % | 40 % | 40 % | 40 % | 40 % | 40 % |
| 70 % | 70 % | 70 % | 70 % | 70 % | 70 % |
| 100 % | 100 % | 100 % | 100 % | 100 % | 100 % |

### 5.1.2 Flow calibration at atmospheric pressure

Verification is based on PTB Testing Specification vol. 29 "Gas volume flow meter testing using air at atmospheric pressure".

For a further increase in the measuring accuracy, the FLOWSIC600 provides Reynolds-number- and velocity-related impact correction routines. These nominal size-dependent parameters were determined prior to the verification procedure and are set as manufacturer constants at the factory. The important assignment of the Reynolds number range is carried out with the help of the "Pressure (fix)" parameter.


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For calibration with air at atmospheric pressure, call up the “Calibration” function on the LC display. This will reset the “Pressure (fix)” parameter to 1.0 bar (a). The word “Calibration” will appear on the display while the device is being calibrated.

After calibration and adjustment, the FLOWSIC600 must be set to one of the following operating pressure ranges by setting the “Pressure (fix)” parameter (see **Fig. 4.8**).

| | **Rated pressure range** | |
|---|---|---|
| | $\mathbf{p}_{e,\,min}$ | $\mathbf{p}_{e,\,max}$ |
| 1 bar(a) | 0 bar | 0.1 bar |
| 1.5 bar(a) | 0.1 bar | 1.0 bar |
| 3.2 bar(a) | 1.0 bar | 4.0 bar |

ATTENTION

**Warning**
The maximum permitted operating pressure of a gas flow meter verified at atmospheric pressure must not exceed 4 bar(g).

### 5.1.3 Flow calibration at high pressure

Verification is based on PTB Testing Specification vol. 30 “High pressure testing of gas meters”. The FLOWSIC600 should be tested under the same conditions and using the same type of gas which will be used during normal operation.

**Determining the test pressure**

The minimum ($p_{e,\,min}$) and maximum ($p_{e,\,max}$) operating pressure must be identical to the operating pressure range the meter has been applied for.

ATTENTION

**Warning**
The maximum operating pressure must, however, not exceed the maximum pressure resistance of the meter body.

The maximum permitted operating pressure is specified as $P_S$ on the type plate of the meter body. The permitted working pressure range of the meter is derived from the “Pressure (fix)” parameter ($p_{fix}$). Prior to the verification procedure, this parameter must be set to the working pressure applied during testing. The gas pressure applied during testing should be identical to the average working pressure in the installation. If the final working pressure exceeds 50 bar, testing at 50 bar will be sufficient.

The maximum ratio of minimum and maximum operating pressure is:

$$\frac{p_{e,\,max}}{p_{e,\,min}} = \leq 4$$

Generally,

$$p_{fix} = \sqrt{p_{e,\,min} \bullet p_{e,\,max}} + 1\ bar$$

where

$$p_{e,\,min} = 0{,}5 \bullet p_{fix}$$

$$p_{e,\,max} = 2 \bullet p_{fix} \qquad \text{if } p_{fix} \leq 0.5\ P_S\text{; otherwise } P_S$$


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If the calibration is based on several test pressures, the “Pressure (fix)” parameter must be reset to the applicable test pressure before each test. The corresponding operating pressure range is displayed on the FLOWSIC600 as calculated in accordance with these equations.

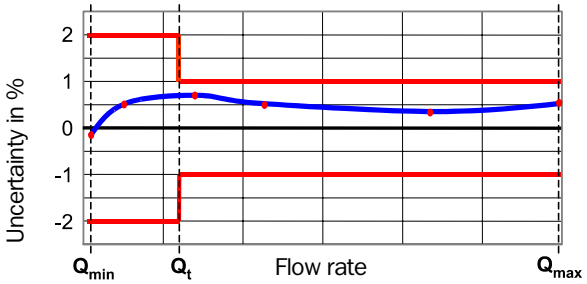
The test pressure which comes closest to the average plant working pressure shall be entered as the “Pressure (fix)” parameter. The meter shall then be adjusted with the weighted mean error established at this test pressure.

**Note** Enter the absolute value of the average working pressure when setting the “Pressure (fix)” parameter.

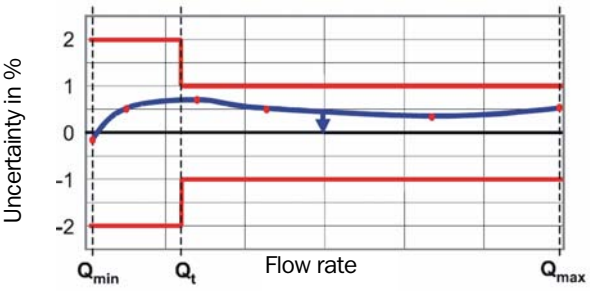
### 5.1.4 Calibration overview

Generally, a calibration involves the following steps:

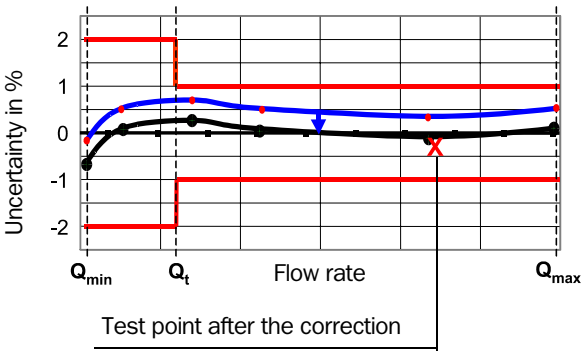
1. Flow rate measurement at the defined test points




2. Flow-rate-weighted calculation of the error (WME) over the entire measuring range in % (blue arrow)




3. Calculation of the adjust factor and entering it as a parameter in the FLOWSIC600




The black line is the calculated characteristic line, i.e. the product of the previously measured points and the adjust factor.

Then, the flow rate is determined again at a test point in order to find out whether or not the value measured by the unit under test is identical to the calculated value.

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## 5.2 Preparation

### 5.2.1 Installation on the flow test stand

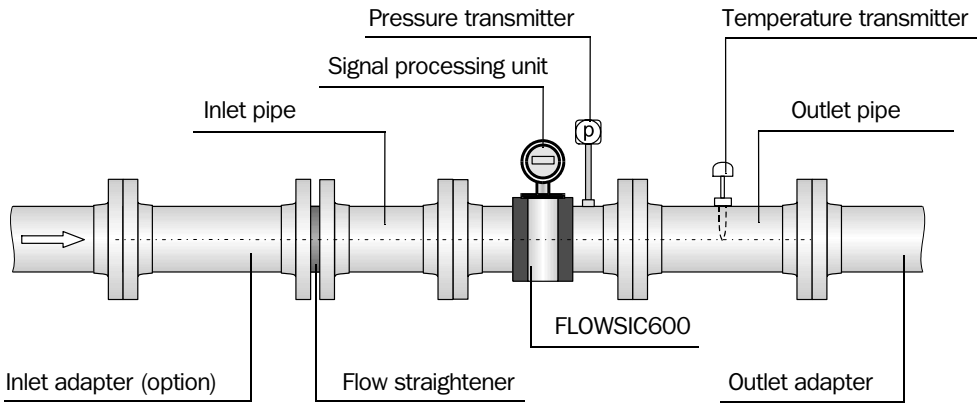


Fig. 5.1: Installation of the FLOWSIC600 in the test pipeline

Detailed information about the installation in the pipeline and about necessary inlet and outlet pipes can be found in the Operating Instruction, Section 3.2 and Section 3.3.

### 5.2.2 Electrical connection

After having removed the back cover, the FLOWSIC600 must be connected electrically as shown in the Figure below.

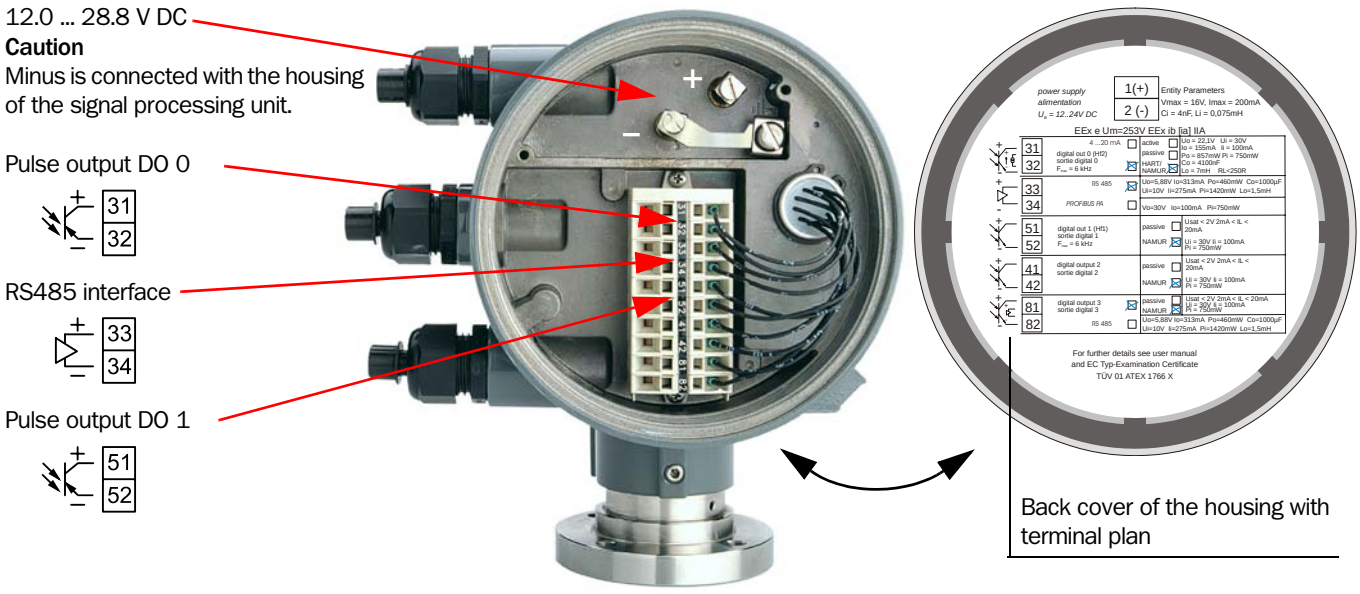


Fig. 5.2: Electrical connections in the signal processing unit

Setting the pulse outputs to “Open collector” or “NAMUR” is described in Section *3.4.7*. The default configuration is indicated in the terminal assignment plan inside the back cover of the housing.


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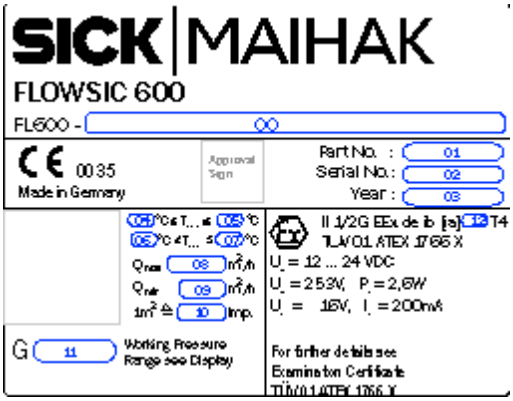
### 5.2.3 Checking the device design

The information provided in the boxes marked “00” to “12” (see **Fig. 5.3**) of the type plate at the signal processing unit must conform with the information in the device documentation.

Type plate at the signal processing unit




Type plate at the meter body

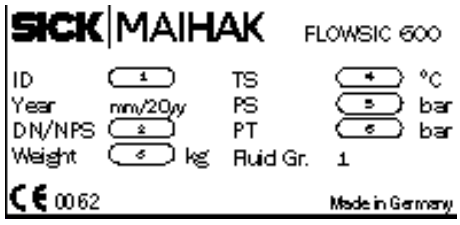



Fig. 5.3: FLOWSIC600 type plates

Information on nominal size (DN/NPS), design temperature (TS), design pressure (PS) and test pressure (PT) can be found on the type plate at the meter body.

DANGER

**Warning**

The operating pressure must not exceed the design pressure (PS) during the calibration.

### 5.2.4 Connecting the FLOWSIC600 with the MEPAFLOW600 program

#### Connecting the FLOWSIC600 with a PC or laptop

Adapter, cable and power supply unit can be ordered as an interface set from SICK MAIHAK, part no. 7041773.

The serial interface at the FLOWSIC600 conforms with the RS485 standard. An RS485-RS232 cable and an 1:1 interface cable (pin 2 – pin 2 and pin 3 – pin 3) are required for data transfer to the PC or laptop (see **Fig. 5.4**). Because MEPAFLOW600 does not support RTS/CTS data transfer, the adapter must be able to distinguish between transmission and reception mode automatically.

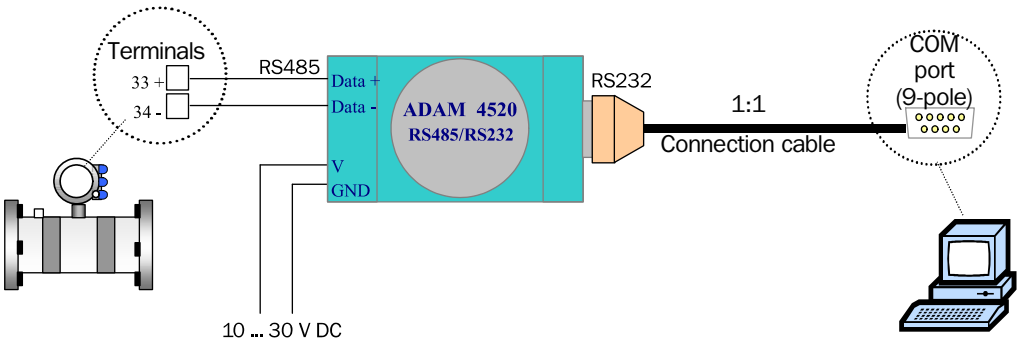



Fig. 5.4: Wiring example of the ADAM 4520 RS485 / RS232 converter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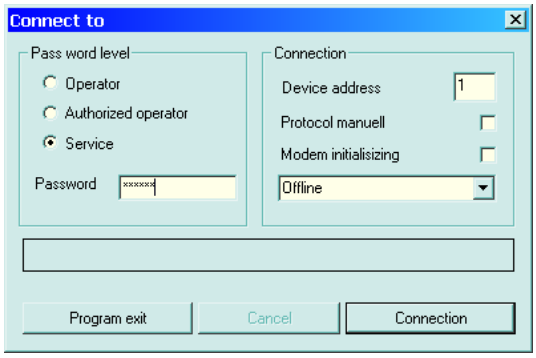
### Run the MEPAFLOW600 programme

Details on installation and operation of the MEPAFLOW600 programme can be found in the Software Manual.

- Run the MEPAFLOW600 control and configuration programme.
- In the “Connection” menu, select the level “Authorized operator” and enter the password “sickoptic”.
- Select an available COM port of the computer.
- Click on the “Connection” button.

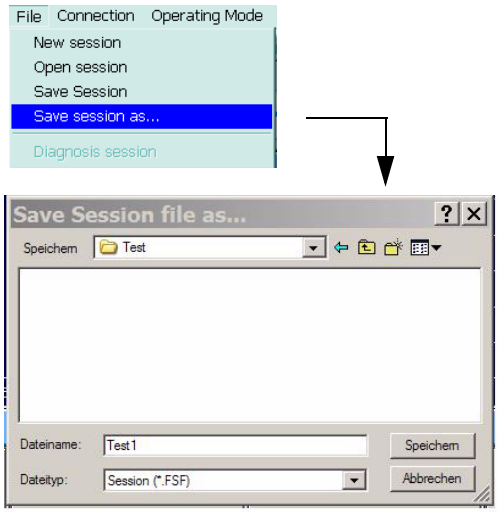



A confirmation dialog box will appear. If there is an existing file of an earlier calibration, and if you want to use that file, click “Yes”. Otherwise, a new session file must be created as described below.

## 5.2.5 Creating a new session file

If you want to open an existing session file, select the menu item “Open session”.

- Open “New session“ from the “File“ menu.
- Select the menu item “Save session as ..”.
- Enter a file name. The file name should contain serial number and size of the unit under test, e.g. 04458703_NPS8.
- In the “Session information” dialog box, only activate “FLASH segment” (this will do for a calibration session).



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### 5.2.6 Open / close the configuration protection switch

In order to be able to calibrate the FLOWSIC600, the configuration protection must be disabled. You may call up “System status” from the “Monitors“ menu to check the setting.

Lamp is on: configuration protection is active.

Lamp is off: configuration protection is disabled.

**Monitor: Device state**

| Bit | Sys | System state register | P1 | P2 | P3 | P4 | Path state registers | Ctrl | System control register |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | Measure mode | | | | | Warning SNR | | Configuration mode |
| 1 | | Measure valid | | | | | Warning AGC Deviation | | Path 1 deactived |
| 2 | | Check Request | | | | | Warning AGC Limit | | Path 2 deactived |
| 3 | | Limit warning | | | | | Warning SOS Deviation | | Path 3 deactived |
| 4 | | Hardware write lock | | | | | Read signal from DSP | | Path 4 deactived |
| 5 | | Path error 1 | | | | | Divide by Zero | | Path 1 checkcycle |
| 6 | | Path error 2 | | | | | MAX too big | | Path 2 checkcycle |
| 7 | | Path error 3 | | | | | MAX too small | | Path 3 checkcycle |
| 8 | | Path error 4 | | | | | MAXPOS too early | | Path 4 checkcycle |
| 9 | | CRC Error | | | | | MAXPOS too late | | Reset error volumen counters |
| 10 | | Parameter invalid | | | | | Path error | | Imperial system of measurement |
| 11 | | Adjust range | | | | | SNR exceeds limit | | Filter mode |
| 12 | | IO Range error | | | | | Maximum Iterations | | Testing watchdog |
| 13 | | DSP Error | | | | | Time plausibility | | Reset path conditions |
| 14 | | Path compensation valid | | | | | Check cycle | | Continious measure mode |
| 15 | | DSP Parameter error | | | | | Limit MSE | | Airtest |

Fig. 5.5: “Monitors/System status” menu

If the configuration protection is active, the switch must be turned to its “open” position to be able to change any parameters (see **Fig. 5.6**).

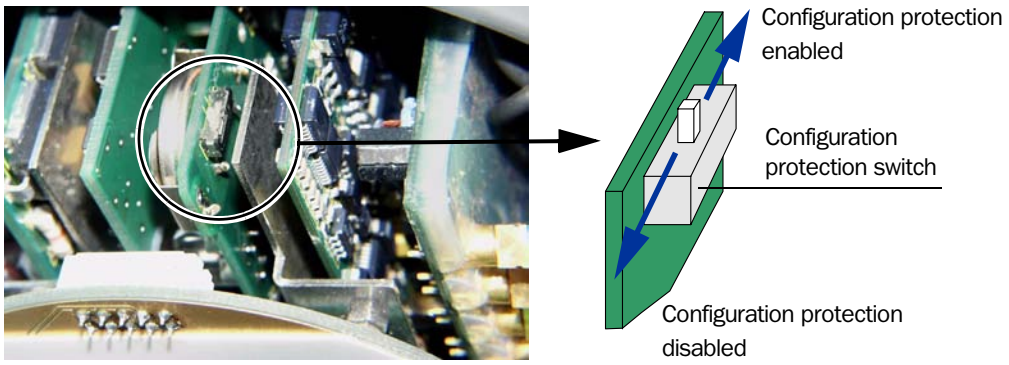


Fig. 5.6: Configuration protection switch

- Disconnect the FLOWSIC600 from the power supply.
- Take off the front cap of the signal processing unit.
- Move the switch to the desired position.
- Mount the front cap again.
- Reconnect the power supply.


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## 5.3 Calibrating the FLOWSIC600

Before you can start the calibration, the process parameters “Temperature (fixed)” (register #7040) and “Pressure (fixed)” (register #7041) must be set to the actual conditions during the calibration; these parameters can be edited on the “Device parameters” tab.

The FLOWSIC600 must be switched to the configuration mode in order to be able to edit parameters.

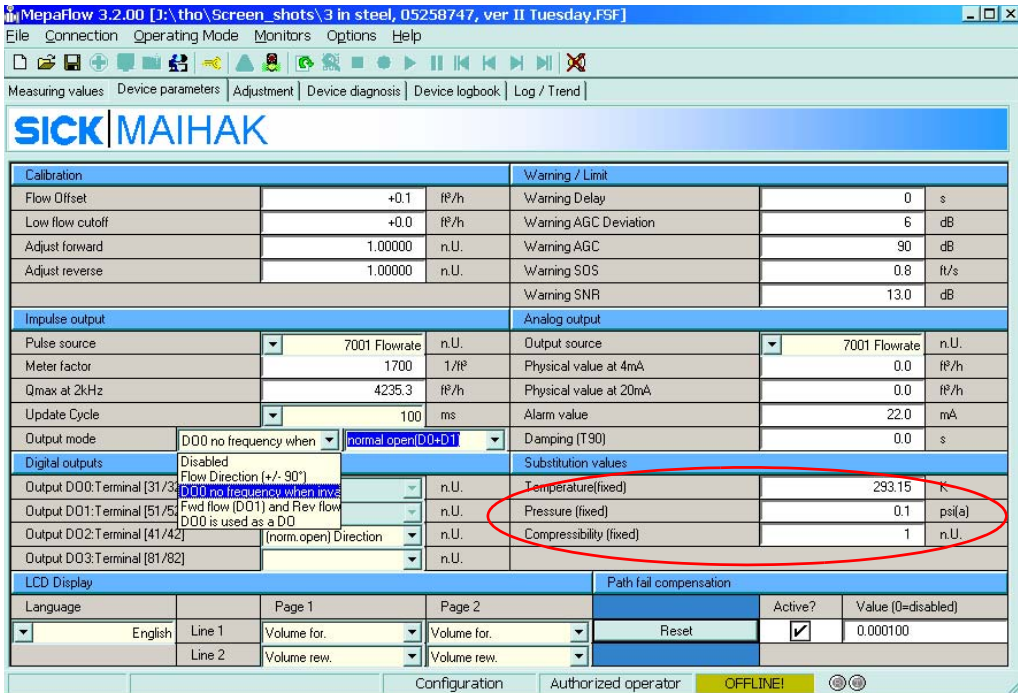


Fig. 5.7: “Device parameters” tab

Change back to the measurement mode after having edited the parameters.

Once the first flow rate value has been measured, check the error limits (“Measuring values” tab, see **Fig. 5.8**). These limits should be lower than 25 per cent in all paths. If the velocity of gas is greater than 30 m/s, the error rate may be significantly higher.

In addition, check the “Device status” boxes for possible malfunctions.

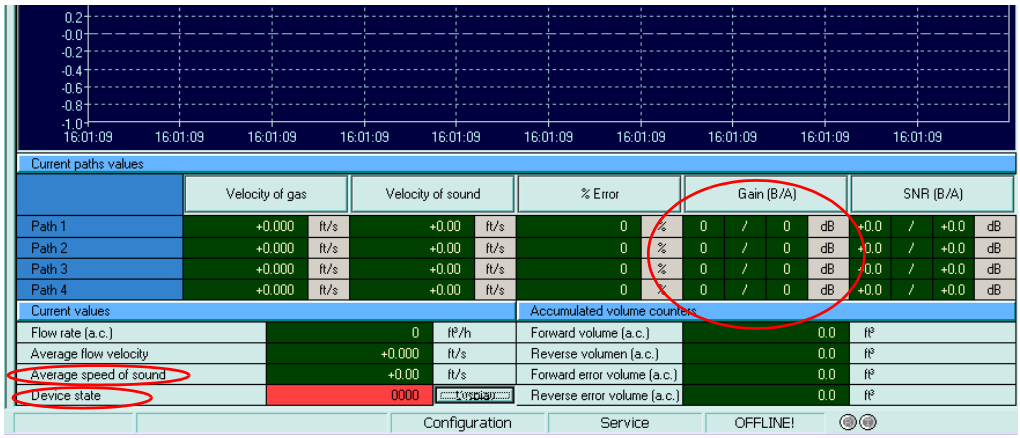


Fig. 5.8: “Measuring values” tab (detail)


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Correction of settings, see Service manual Section 6.2.1

Now check the “ZeroPhase” parameter in all paths. Correctly adjusted zero phases of the individual paths are the basis for accurate transit time measurement of the ultrasonic signals.
The “ZeroPhase” parameters are correctly adjusted if the red cursor (COR = corrected runtime) is at least close to and the blue cursor (RT = runtime) is exactly on the second positive zero passage of the received ultrasonic signal (see **Fig. 5.9**).

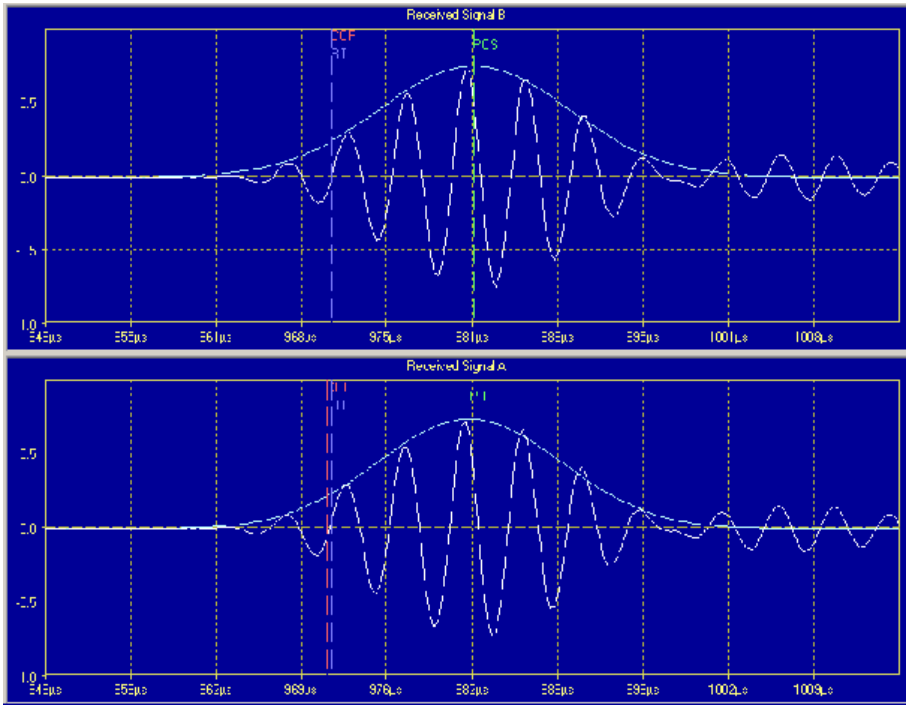
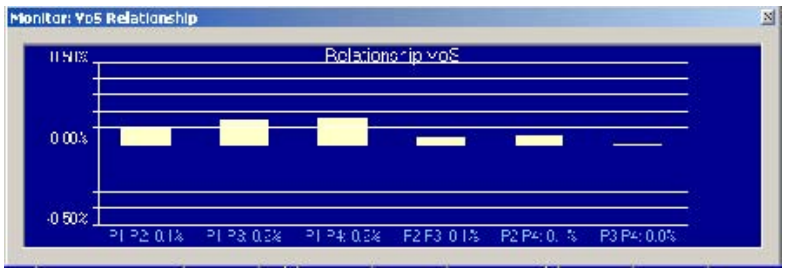



Fig. 5.9: Received ultrasonic signals, position of the evaluation lines COR and RT

Correctness of the zero passages can be verified with the help of the deviations of the velocity of sound among the individual paths (“Monitor /VOS relationship” menu, see **Fig. 5.10**) and a comparison of the velocity of sound measured by the FLOWSIC600 with the theoretical value (see Service manual Section 6.2.1).




Max. deviation
± 0.1 %

Fig. 5.10: MEPAFLOW600 “Monitors/VOS relationship” menu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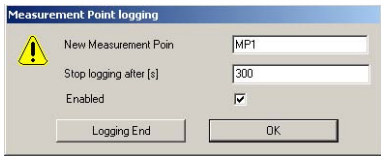
### 5.3.1 Data logging (optional)

It is recommended to record the measured values and diagnosis information for documentation purposes and later use.

- Start data recording.

- Specify a file name.
- Activate the measuring point logging and enter name and duration of the first measuring point.

- Start data logging at the first measuring point. When the measuring period has elapsed, a dialog box will appear where you are requested to enter name and duration of the next measuring point.




The data are structured and saved chronologically in the session file. They can be exported later with the help of the menu item “File/Session history”.

### 5.3.2 Determining and entering the adjust factors

See Section *2.4.2*

Determining the adjust factors is based on the weighted mean error WME of the flow rates $Q_i$. The WME is calculated by the test labs according to the equation:

$$WME = \frac{\sum_{i=1}^{n} k_i \cdot f_i}{\sum_{i=1}^{n} k_i}$$

where $k_i = \frac{Q_i}{Q_{max}}$ for $Q_i \leq 0.7\ Q_{max}$

and $k_i = 1.4 - \frac{Q_i}{Q_{max}}$ for $0.7\ Q_{max} < Q_i \leq Q_{max}$

Q: Tested flow rate
$Q_{max}$: Tested maximum flow rate
fi: Weighted mean error in % established at the tested flow rate

If the meter is calibrated for bidirectional use, the weighted mean error is determined using the values established separately for each direction of flow.

Adjustment with constant factor

The new adjust factor is calculated as follows:

$$AF = \frac{1}{1 + \frac{WME}{100\ \%}}$$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The new adjust factors must now be entered in the FLOWSIC600 as follows:

- In the MEPAFLOW600 programme, switch the measuring system to the configuration mode and call up the “Device parameters” tab.
- Enter the new adjust factors in the “Calibration” box.
- Change back to the measuring mode.

Then verify the adjustment by repeating a measurement at a certain test flow rate, and repeat the steps above if necessary.

Finally, in the parameters “Pressure (fix)” and “Temperature (fix)” (see **Fig. 5.11**), enter the values that apply to the original installation of the meter, if known (in the configuration mode).

After completion of the steps above, reactivate the configuration protection.

- Disconnect the FLOWSIC600 from the power supply.
- Take off the front panel of the signal processing unit.
- Move the switch to the desired position see Section *5.2.6*).
- Mount the front cap again.
- Reconnect the power supply.
- Create the documentation according to Section *5.3.4*.

After establishment of the documentation the „standard“ calibration is finished.

The following section describes two other possibilities of adjustment procedures using MEPAFLOW600 software.

### 5.3.3 Finding the adjust factors using the MEPAFLOW600 software

TYPE APPROVAL

The following methods are implemented in the FLOWSIC600 firmware:

- Adjustment with constant factor
- Adjustment using an error polynomial
- Adjustment with piece wise linear error interpolation

**Note** The method ’’correction with piece wise linear error interpolation’’ is not approved for use in custody transfer applications in every country.

Use the “Adjustment” tab in the MEPAFLOW600 control and configuration programme (see **Fig. 5.11**) in order to calculate the required adjust factors. The tested flow rates and the corresponding errors must be listed in a tabular form for this. After selection of the desired correction method, click on the “Calculate adjust” button. The correction factors will now be calculated.

In order to check the result of the adjustment, click on “Show curve” and analyse the diagram that will appear.

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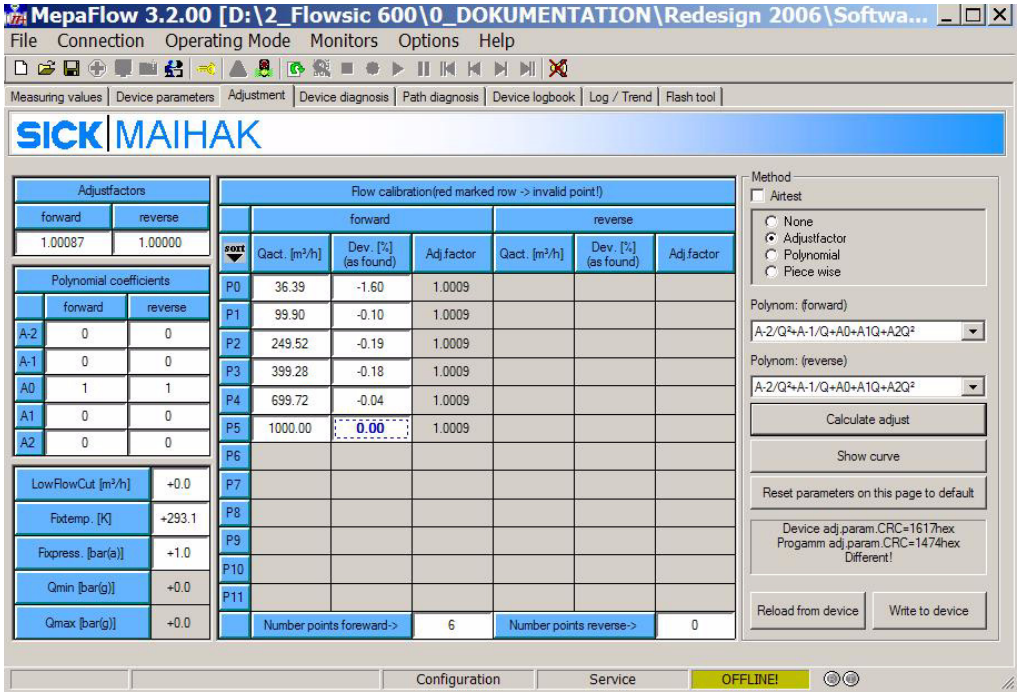


Fig. 5.11: “Adjustment” tab

### Adjustment with constant factor

The adjust factor is calculated from WME as follows:

$$AF = \frac{1}{1 + \frac{WME}{100\ \%}}$$

After setting the adjust factor to the meter (see **Fig. 5.7**) return to the measuring mode. Then check the WME (AF) by repeating a flow measurement at a certain test flow rate.

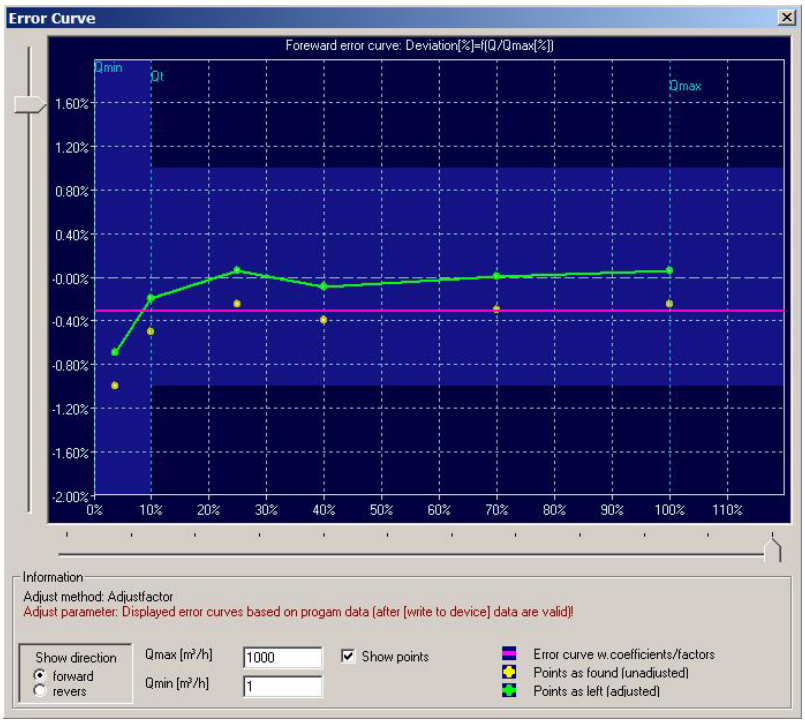


Fig. 5.12: “Adjustment/Show curve” tab representing adjustment with constant factor


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### Adjustment using a polynomial

The following polynomials are implemented in the FLOWSIC600 firmware in order to provide for a flow-specific adjustment of the error characteristic:

$E'(Q) = a_{-2}Q^{-2} + a_{-1}Q^{-1} + a_0 + a_1Q + a_2Q^2$ (1) 8 sample points

$E'(Q) = a_{-1}Q^{-1} + a_0 + a_1Q + a_2Q^2$ (2) 7 sample points

$E'(Q) = a_0 + a_1Q + a_2Q^2$ (3) 6 sample points

The adjustment using a polynomial must only be used if the minimum number of sample points for finding the polynomial coefficients in the range to be calibrated have been determined. The adjustment factor is in this case calculated by the FLOWSIC600 depending on the actual flow rate.

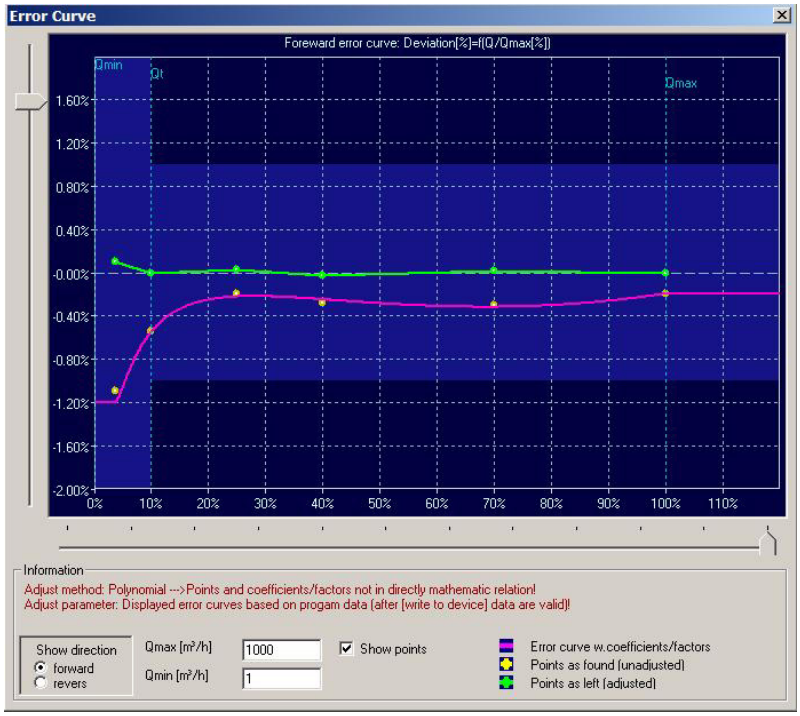


Fig. 5.13: “Adjustment/Show curve” tab representing adjustment using a polynomial

Change back to the measurement mode after having entered the polynomial coefficients. Then check the weighted mean error calculated after adjustment by repeating a measurement with at least two different test flow rates. The test flow rates used shall lie between two already examined test flow rates. For example, if the errors at 100 % and 70 % $Q_{max}$ have already been found, the correction using a polynomial shall be tested at 80 % $Q_{max}$.

The flow-rate specific correction is calculated by the meter as follows:

$$AF(Q) = \frac{1}{1 + \frac{E'(Q)}{100\ \%}}$$

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### Adjustment using piece wise linear error interpolation

This adjustment method is carried out just as the polynomial adjustment. In this method, the error is corrected exactly to zero at the individual calibration points. Now, a linear interpolation and error correction is carried out between the individual calibration points.

Fig. 5.14: “Adjustment/Show curve” tab representing adjustment with linear error interpolation


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### 5.3.4 Documentation

After having completed the calibration, the current device configuration shall be documented. To do so, connect a printer to the PC, select “Current device configuration” from the “File/session history” menu and click on “Print entry”; see **Fig. 5.15**). Attach this print to the test records. If no printer is available at this point, the configuration log can also be printed later, all relevant parameters are stored in the session file. Therefore, do not forget to save the session file (see **Fig. 5.16** to **Fig. 5.21**)!

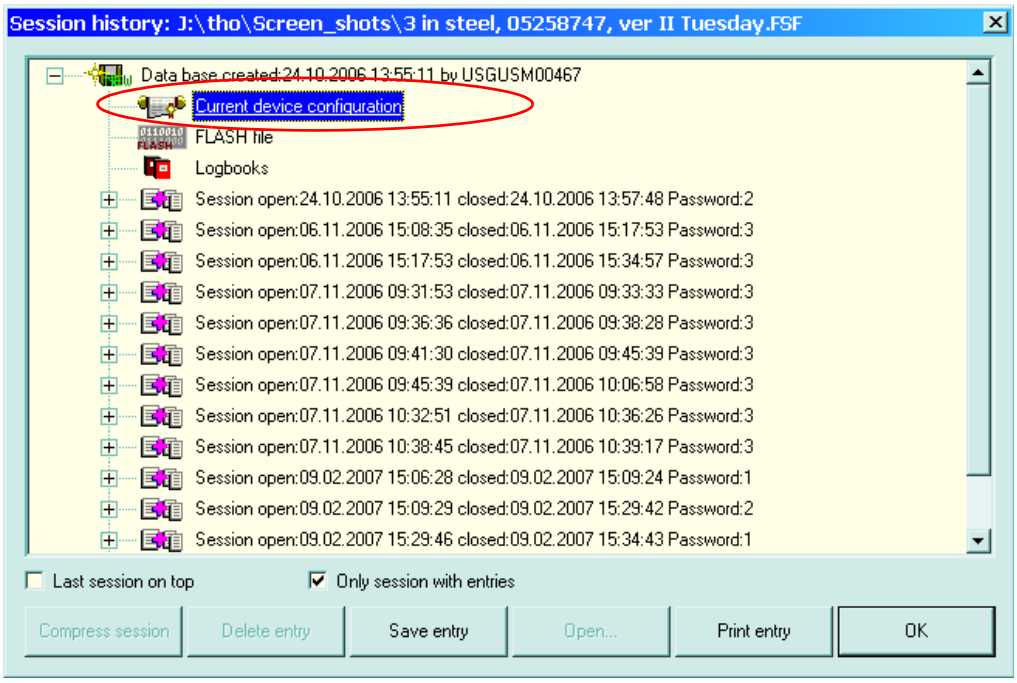
Session history: J:\tho\Screen_shots\3 in steel, 05258747, ver II Tuesday.FSF
Data base created:24.10.2006 13:55:11 by USGUSM00467
Current device configuration
FLASH file
Logbooks
Session open:24.10.2006 13:55:11 closed:24.10.2006 13:57:48 Password:2
Session open:06.11.2006 15:08:35 closed:06.11.2006 15:17:53 Password:3
Session open:06.11.2006 15:17:53 closed:06.11.2006 15:34:57 Password:3
Session open:07.11.2006 09:31:53 closed:07.11.2006 09:33:33 Password:3
Session open:07.11.2006 09:36:36 closed:07.11.2006 09:38:28 Password:3
Session open:07.11.2006 09:41:30 closed:07.11.2006 09:45:39 Password:3
Session open:07.11.2006 09:45:39 closed:07.11.2006 10:06:58 Password:3
Session open:07.11.2006 10:32:51 closed:07.11.2006 10:36:26 Password:3
Session open:07.11.2006 10:38:45 closed:07.11.2006 10:39:17 Password:3
Session open:09.02.2007 15:06:28 closed:09.02.2007 15:09:24 Password:1
Session open:09.02.2007 15:09:29 closed:09.02.2007 15:29:42 Password:2
Session open:09.02.2007 15:29:46 closed:09.02.2007 15:34:43 Password:1
Last session on top
Only session with entries
Compress session
Delete entry
Save entry
Open...
Print entry
OK

Fig. 5.15: “File / Session history / Current device configuration” menu

### 5.3.5 Sealing

Carry out the following securing measures in accordance with the sealing plan after completion of the calibration (see Section *9.7*):

- Turn on the configuration protection switch (see **Fig. 5.6**).

**Note** If you use a FLOWSIC600 with LC display, the character ’#’ will appear on the LCD if the configuration protection switch is turned on(see Section *9.2.2*).

- Close the front cap of the SPU and seal it using the securing bracket and wire lead.
- Seal all transducer cover caps with at least two stickers.
- Attach the main lead to the main type plate on the SPU.
- Attach and secure an additional plate that provides information on permitted type of gas and permitted operating pressure range.

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| FLOWSIC 600 configuration protocol (parameters) | | | | 03.05.2006 | 15:06:35 |
|---|---|---|---|---|---|
| User name | xxxxxxxxx | | Location | | |

| Device identifikation | | | | | |
|---|---|---|---|---|---|
| DeviceType | SerialNumberDevice | SoftwareVersion | ProgramCRC | ParameterCRC | ConstantsCRC |
| *Reg. 3001* | *Reg. 5001* | *Reg. 5002* | *Reg. 5005* | *Reg. 5006* | *Reg. 5004* |
| Date | Time | | | | |
| *Reg. 5007* | *Reg. 5008* | | | | |

| Interfaces | | | | | |
|---|---|---|---|---|---|
| Impulse output | MeterFactor [ 1/m³] | FreqSourceReg | PulseUpdateRate | | |
| | *Reg. 7027* | *Reg. 3026* | *Reg. 7043* | | |
| Analog output | AORangeLow | AORangeHigh | AOSourceReg | AOTimeConstant [s] | AOError [mA] |
| | *Reg. 7028* | *Reg. 7029* | *Reg. 3025* | *Reg. 7030* | *Reg. 7032* |
| ModBus(1)BaudRate | ModBus(1)ResponceDelay | ModBus(1)ControlReg | DeviceBusaddress | | |
| *Reg. 5021* | *Reg. 5022* | *Reg. 5023* | *Reg. 5020* | | |
| Service(2)BaudRate | Service(2)ResponceDelay | Service(2)ControlReg | DeviceBusaddress | | |
| *Reg. 5024* | *Reg. 5025* | *Reg. 5026* | *Reg. 5020* | | |
| Extended(3)BaudRate | Extended(3)ResponceDelay | Extended(3)ControlReg | DeviceBusaddress | | |
| *Reg. 5027* | *Reg. 5028* | *Reg. 5029* | *Reg. 5020* | | |
| LCD Display | LCDLanguage | LCDSource | | | |
| | *Re. 3030* | *Reg. 3031* | | | |

| Meter body | | | | |
|---|---|---|---|---|
| InnerDiameter [m] | NumberPaths | ExpCorrTemperature | ExpCorrPressure | MaxPressure |
| *Reg. 7100* | *Reg. 3500* | *Reg. 7118* | *Reg. 7117* | *Reg. 7044* |
| | Path 1 | Path 2 | Path 3 | Path 4 |
| Length 1 [m] | *Reg. 7105* | *Reg. 7106* | *Reg. 7107* | *Reg. 7108* |
| Angle 1 [rad] | *Reg. 7101* | *Reg. 7102* | *Reg. 7103* | *Reg. 7104* |
| Weight 1 [o.E.] | *Reg. 7120* | *Reg. 7121* | *Reg. 7122* | *Reg. 7123* |

| Ultrasonic sensors | | | | |
|---|---|---|---|---|
| | Path 1 | Path 2 | Path 3 | Path 4 |
| SensorLength A [m] | Reg. 7109 | Reg. 7111 | Reg. 7113 | Reg. 7115 |
| SensorLength B [m] | Reg. 7110 | Reg. 7112 | Reg. 7114 | Reg. 7116 |
| TimeOffset AB [s] | Reg. 7140 | Reg. 7142 | Reg. 7144 | Reg. 7146 |
| TimeOffset BA [s] | Reg. 7141 | Reg. 7143 | Reg. 7145 | Reg. 7147 |
| ZeroPhase AB [rad] | Reg. 7156 | Reg. 7158 | Reg. 7160 | Reg. 7162 |
| ZeroPhase BA [rad] | Reg. 7157 | Reg. 7159 | Reg. 7161 | Reg. 7163 |
| SerialNumberSensor A | Reg. 5030 | Reg. 5032 | Reg. 5034 | Reg. 5036 |
| SerialNumberSensor B | Reg. 5031 | Reg. 5033 | Reg. 5035 | Reg. 5037 |

| Signal Processing Unit (SPU) | | | | |
|---|---|---|---|---|
| | Path 1 | Path 2 | Path 3 | Path 4 |
| TimeOffsetHW AB [s] | Reg. 7148 | Reg. 7150 | Reg. 7152 | Reg. 7154 |
| TimeOffsetHW BA [s] | Reg. 7149 | Reg. 7151 | Reg. 7153 | Reg. 7155 |
| SerialNumberAnalog | Reg. 5003 | | | |
| SampleRate | Reg. 3501 | | | |
| AvgBlockSize | Reg. 3502 | | | |

| Process parameters (fixed) | | | Base conditions | | |
|---|---|---|---|---|---|
| Temperature (fixed) [K] | Pressure (fixed) [bar(a)] | Compressebility (fixed) | TemperatureBase [K] | PressureBase [bar(a)] | CompressBase |
| Reg. 7021 | Reg. 7022 | Reg. 7023 | Reg. 7024 | Reg. 7025 | Reg. 7026 |

| Warning levels | | | | |
|---|---|---|---|---|
| WarningDuration [s] | WarningSNR [dB] | WarningAGC [dB] | WarningAGCDeviation [dB] | WarningSOSDeviation [m/s] |
| Reg. 5015 | Reg. 7211 | Reg. 3515 | Reg. 3507 | Reg. 7205 |

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Fig. 5.16: Registers listed in the configuration protocol (page 1)


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| FLOWSIC 600 configuration protocol (parameters) | | | 23.03.2007 | 13:42:00 |
|---|---|---|---|---|
| User name | LAP312 | Location | | |

| Device identifikation | | | | | |
|---|---|---|---|---|---|
| DeviceType | SerialNumberDevice | SoftwareVersion | ProgramCRC | ParameterCRC | ConstantsCRC |
| 841 | 22078700 | 2202 | 9FE9(hex) | BE6B(hex) | 5D95(hex) |
| Date | Time | | | | |
| 06.06.2006 | 18:08:58 | | | | |

| Interfaces | | | | | |
|---|---|---|---|---|---|
| Impulse output | MeterFactor [ 1/m³] | FreqSourceReg | PulseUpdateRate | | |
| | 1800 | 7001 | 0.1 | | |
| Analog output | AORangeLow | AORangeHigh | AOSourceReg | AOTimeConstant [s] | AOError [mA] |
| | 0.0 | 4000.0 | 7001 | 0.0 | 22.0 |
| Ser.Interfaces | ModBus(1)BaudRate | ModBus(1)ResponceDelay | ModBus(1)ControlReg | DeviceBusaddress | |
| | 9600 | 0 | 01080101(hex) | 1 | |
| | Service(2)BaudRate | Service(2)ResponceDelay | Service(2)ControlReg | DeviceBusaddress | |
| | 9600 | 0 | 01080101(hex) | 1 | |
| | Extended(3)BaudRate | Extended(3)ResponceDelay | Extended(3)ControlReg | DeviceBusaddress | |
| | 9600 | 0 | 01080101(hex) | 1 | |
| LCD Display | LCDLanguage | LCDSource | | | |
| | 1 | 0021(hex) | | | |

| Meter body | | | | | |
|---|---|---|---|---|---|
| InnerDiameter [m] | PipeDiameter [m] | NumberPaths | ExpCorrTemperature | ExpCorrPressure | MaxPressure [bar(g)] |
| 0.18999 | 0.20000 | 4 | 4.12e-005 | 6e-006 | 100.0 |
| | Path 1 | Path 2 | Path 3 | Path 4 | |
| Length 1 [m] | 0.20798 | 0.28698 | 0.28699 | 0.20800 | |
| Angle 1 [rad] | 1.04765 | 1.04756 | 1.04762 | 1.04798 | |
| Weight 1 [o.E.] | 0.1382 | 0.3618 | 0.3618 | 0.1382 | |

| Ultrasonic sensors | | | | |
|---|---|---|---|---|
| | Path 1 | Path 2 | Path 3 | Path 4 |
| SensorLength A [m] | 0.03897 | 0.03901 | 0.03899 | 0.03897 |
| SensorLength B [m] | 0.03902 | 0.03903 | 0.03900 | 0.03900 |
| TimeOffset AB [s] | 1.74974e-005 | 1.74139e-005 | 1.74105e-005 | 1.74694e-005 |
| TimeOffset BA [s] | 1.74979e-005 | 1.74121e-005 | 1.74122e-005 | 1.74704e-005 |
| ZeroPhase AB [rad] | -0.3 | -0.3 | +0.7 | +0.7 |
| ZeroPhase BA [rad] | -0.3 | -0.3 | +0.7 | +0.7 |
| SerialNumberSensor A | 05470085 | 05470070 | 05470072 | 05470197 |
| SerialNumberSensor B | 05470025 | 05470030 | 05470032 | 05470040 |

| Signal Processing Unit (SPU) | | | | |
|---|---|---|---|---|
| | Path 1 | Path 2 | Path 3 | Path 4 |
| TimeOffsetHW AB [s] | 2.4741e-007 | 2.2481e-007 | 2.3697e-007 | 2.5287e-007 |
| TimeOffsetHW BA [s] | 2.4609e-007 | 2.2409e-007 | 2.4093e-007 | 2.5413e-007 |
| DiffractionTime [s] | 0 | 0 | 0 | 0 |
| SerialNumberAnalog | 05420160 | | | |
| SampleRate | 10 | | | |
| AvgBlockSize | 100 | | | |

| Process parameters (fixed) | | | Base conditions | | |
|---|---|---|---|---|---|
| Temperature (fixed) [K] | Pressure (fixed) [bar(a)] | Compressebility (fixed) | TemperatureBase [K] | PressureBase [bar(a)] | CompressBase |
| 285.15 | 30.0 | 1 | 293.15 | 1.0 | 1 |

| Warning levels | | | | |
|---|---|---|---|---|
| WarningDuration [s] | WarningSNR [dB] | WarningAGC [dB] | WarningAGCDeviation [dB] | WarningSOSDeviation [m/s] |
| 30 | 13.0 | 93 | 6 | 10.0 |

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Fig. 5.17: Example of a configuration protocol (page 1)

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| FLOWSIC 600 configuration protocol (adjustment constants) | | | | 03.05.2006 | 15:06:35 |
|---|---|---|---|---|---|

| Calibration | | | | | |
|---|---|---|---|---|---|
| Adjust mode | Adjust CRC | | | | |
| Reg. 3051 | Reg. 3052 | | | | |
| LowFlowCutoff [m³/h] | ZeroFlowOffset [m³/h] | Temperature (fixed) [K] | Pressure (fixed) [bar(a)] | Pe,min [bar(g)] | Pe,max [bar(g)] |
| Reg. 7036 | Reg. 7039 | Reg. 7040 | Reg. 7041 | eg. 7700 | Reg. 7701 |

| Adjust factors | |
|---|---|
| AdjustFactorForward | AdjustFactorReverse |
| Reg. 7037 | Reg. 7038 |

| Polynominal coefficients | | | | |
|---|---|---|---|---|
| Adjust [a-2]fw. | Adjust [a-1]fw | Adjust [a0]fw | Adjust [a1]fw | Adjust [a2]fw |
| Reg. 7400 | Reg. 7401 | Reg. 7402 | Reg. 7403 | Reg. 7404 |
| Adjust [a-2]re | Adjust [a-1]re | Adjust [a0]re | Adjust [a1]re | Adjust [a2]re |
| Reg. 7405 | Reg. 7406 | Reg. 7407 | Reg. 7408 | Reg. 7409 |

| Flow calibration | | | | |
|---|---|---|---|---|
| Adjust Pnt.cnt foreward | Adjust Pnt.cnt reward | | | |
| Reg. 5053 | Reg. 5054 | | | |
| | Qact. m³/h | k-factor | Qact. m³/h | k-factor |
| Pnt.0 | Reg. 7410 | Reg. 7411 | Reg. 7412 | Reg. 7413 |
| Pnt.1 | Reg. 7414 | Reg. 7415 | Reg. 7416 | Reg. 7417 |
| Pnt.2 | Reg. 7418 | Reg. 7419 | Reg. 7420 | Reg. 7421 |
| Pnt.3 | Reg. 7422 | Reg. 7423 | Reg. 7424 | Reg. 7425 |
| Pnt.4 | Reg. 7426 | Reg. 7427 | Reg. 7428 | Reg. 7429 |
| Pnt.5 | Reg. 7430 | Reg. 7431 | Reg. 7432 | Reg. 7433 |
| Pnt.6 | Reg. 7434 | Reg. 7435 | Reg. 7436 | Reg. 7437 |
| Pnt.7 | Reg. 7438 | Reg. 7439 | Reg. 7440 | Reg. 7441 |
| Pnt.8 | Reg. 7442 | Reg. 7443 | Reg. 7444 | Reg. 7445 |
| Pnt.9 | Reg. 7446 | Reg. 7447 | Reg. 7448 | Reg. 7449 |
| Pnt.10 | Reg. 7450 | Reg. 7451 | Reg. 7452 | Reg. 7453 |
| Pnt.11 | Reg. 7454 | Reg. 7455 | Reg. 7456 | Reg. 7457 |

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Fig. 5.18: Registers listed in the configuration protocol (page 2)


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| *FLOWSIC 600 configuration protocol (adjustment constants)* | *23.03.2007* | *13:42:00* |
|---|---|---|

*Calibration*

| *Adjust mode* | *Adjust CRC* | | | | |
|---|---|---|---|---|---|
| 1 | 0000(hex) | | | | |
| *LowFlowCutoff [m³/h]* | *ZeroFlowOffset [m³/h]* | *Temperature (fixed) [K]* | *Pressure (fixed) [bar(a)]* | *Pe,min [bar(g)]* | *Pe,max [bar(g)]* |
| +10.0 | +0.0 | 285.15 | 30.0 | 14.5 | 58.0 |

*Adjust factors*

| *AdjustFactorForward* | *AdjustFactorReverse* |
|---|---|
| 1.00340 | 1.00000 |

*Polynominal coefficients*

| *Adjust A-2 fw* | *Adjust A-1 fw* | *Adjust A0 fw* | *Adjust A1 fw* | *Adjust A2 fw* |
|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 0 |
| *Adjust A-2 re* | *Adjust A-1 re* | *Adjust A0 re* | *Adjust A1 re* | *Adjust A2 re* |
| 0 | 0 | 1 | 0 | 0 |

*Flow calibration*

| *Adjust Points foreward* | | | *Adjust Points reverse* | | |
|---|---|---|---|---|---|
| 0 | | | 0 | | |
| *Qact. [m³/h]* | *Dev.(as found) [%]* | *Adj.factor* | *Qact. [m³/h]* | *Dev.(as found) [%]* | *Adj.factor* |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- |



Fig. 5.19: Example of a configuration protocol (page 2)

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| FLOWSIC 600 configuration protocol (constants) | | | | 03.05.2006 | 15:06:35 |
|---|---|---|---|---|---|

| Reynolds correction | | | | | |
|---|---|---|---|---|---|
| Correction CC0 | Correction CC1 | Correction CC2 | Correction CC3 | Correction CC4 | |
| Reg. 7130 | Reg. 7131 | Reg. 7132 | Reg. 7133 | Reg. 7134 | |

| Profile corection | | | | | |
|---|---|---|---|---|---|
| Correction K0 | Correction K1 | Correction K2 | Correction K3 | Correction K4 | Correction K5 |
| Reg. 7124 | Reg. 7125 | Reg. 7126 | Reg. 7127 | Reg. 7128 | Reg. 7129 |
| Corr en_lo | Corr en_hi | ProfileCor.PC0 | ProfileCor.PC1 | | |
| Reg. 7135 | Reg. 7136 | Reg. 7137 | Reg. 7138 | | |

| Limits | | | | |
|---|---|---|---|---|
| SwitchMeasMode [%] | Limit%Error [%] | LimitSNR [dB] | LimitMSE [o.E.] | LimitWidth [%] |
| Reg. 3516 | Reg. 3514 | Reg. 7202 | Reg. 7204 | Reg. 7203 |

| Signal detection | | | | | |
|---|---|---|---|---|---|
| InitWinSize [o.E.] | MeasWinSize [o.E.] | AGCInit [dB] | AGCDamping [o.E.] | MinAmplitude [%] | NormAmplitude [%] |
| Reg. 3503 | Reg. 3504 | Reg. 3505 | Reg. 3506 | Reg. 3509 | Reg. 3510 |

| Signal models | | | | |
|---|---|---|---|---|
| Sensor A | Path 1 | Path 2 | Path 3 | Path 4 |
| TxFreq [Hz] | Reg. 7230 | Reg. 7242 | Reg. 7254 | Reg. 7266 |
| TxPeriods [o.E.] | Reg. 7231 | Reg. 7243 | Reg. 7255 | Reg. 7267 |
| TxPhase [o.E.] | Reg. 7232 | Reg. 7244 | Reg. 7256 | Reg. 7268 |
| TxDuration [s] | Reg. 7233 | Reg. 7245 | Reg. 7257 | Reg. 7269 |
| TxDampOut [o.E.] | Reg. 7234 | Reg. 7246 | Reg. 7258 | Reg. 7270 |
| TxAmplitude [o.E.] | Reg. 7235 | Reg. 7247 | Reg. 7259 | Reg. 7271 |
| Sensor B | Path 1 | Path 2 | Path 3 | Path 4 |
| TxFreq [Hz] | Reg. 7236 | Reg. 7248 | Reg. 7260 | Reg. 7272 |
| TxPeriods [o.E.] | Reg. 7237 | Reg. 7249 | Reg. 7261 | Reg. 7273 |
| TxPhase [o.E.] | Reg. 7238 | Reg. 7250 | Reg. 7262 | Reg. 7274 |
| TxDuration [s] | Reg. 7239 | Reg. 7251 | Reg. 7263 | Reg. 7275 |
| TxDampOut [o.E.] | Reg. 7240 | Reg. 7252 | Reg. 7264 | Reg. 7276 |
| TxAmplitude [o.E.] | Reg. 7241 | Reg. 7253 | Reg. 7265 | Reg. 7277 |
| PostPeriods | PrePeriods 1 | PrePeriods 2 | PrePeriods 3 | PrePeriods 4 |
| Reg. 7280 | Reg. 7281 | Reg. 7282 | Reg. 7283 | Reg. 7284 |
| InitTime [s] | RingOutTime 1 [s] | RingOutTime 2 [s] | RingOutTime 3 [s] | RingOutTime 4 [s] |
| Reg. 7220 | Reg. 7221 | Reg. 7222 | Reg. 7223 | Reg. 7224 |

| Path fail compensation | | | | |
|---|---|---|---|---|
| | Path 1 | Path 2 | Path 3 | Path 4 |
| PathCondStatic | Reg. 7293 | Reg. 7294 | Reg. 7295 | Reg. 7296 |
| PathCondLow | Reg. 7289 | Reg. 7290 | Reg. 7291 | Reg. 7292 |
| PathCondHigh | Reg. 7285 | Reg. 7286 | Reg. 7287 | Reg. 7288 |
| PathCompAverWeight | PathCompClassLo [m/s] | PathCompClassHi [m/s] | PathCompStoreLimit [o.E.] | PathCompValid |
| Reg. 7206 | Reg. 7208 | Reg. 7207 | Reg. 7210 | Reg. 5009 |

| Miscellanous | | | | | |
|---|---|---|---|---|---|
| SystemConfigReg | DOOutputConfigReg | FreqOutputConfigReg | TotalizerResolution [ 1/m³] | MaxVelSound [m/s] | MaxVelGas [m/s] |
| Reg. 3498 | Reg. 5101 | Reg. 5102 | Reg. 5014 | Reg. 7200 | Reg. 7201 |

| AO Adjustment | |
|---|---|
| AOGain [o.E.] | AOOffset [mA] |
| Reg. 7033 | Reg. 7034 |

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Fig. 5.20: Registers listed in the configuration protocol (page 3)


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| FLOWSIC 600 configuration protocol (constants) | | | | 23.03.2007 | 13:42:00 |
|---|---|---|---|---|---|

| Reynolds correction | | | | | |
|---|---|---|---|---|---|
| CorrTreshold | Correction CC0 | Correction CC1 | Correction CC2 | Correction CC3 | Correction CC4 |
| 0 | 0.0237706 | -72103.3 | 1796.71 | 1 | 1.1e-006 |
| | CorrLowPr CC0 | CorrLowPr CC1 | CorrLowPr CC2 | CorrLowPr CC3 | CorrLowPr CC4 |
| | 0 | 0 | 1 | 1 | 0 |

| Profile corection | | | | | |
|---|---|---|---|---|---|
| Correction K0 | Correction K1 | Correction K2 | Correction K3 | Correction K4 | Correction K5 |
| 1.053 | -0.07 | 0.07 | -0.0413 | -0.0328 | -0.051 |
| Corr en_lo | Corr en_hi | ProfileCor.PC0 | ProfileCor.PC1 | | |
| 0.7 | 0.8 | 2.3 | -0.65 | | |

| Limits | | | | |
|---|---|---|---|---|
| SwitchMeasMode [%] | Limit%Error [%] | LimitSNR [dB] | LimitMSE [o.E.] | LimitWidth [%] |
| 70 | 95 | 13.0 | 0.012 | 80 |

| Signal detection | | | | | |
|---|---|---|---|---|---|
| InitWinSize [o.E.] | MeasWinSize [o.E.] | AGCInit [dB] | AGCDamping [o.E.] | MinAmplitude [%] | NormAmplitude [%] |
| 2200 | 600 | 66 | 10 | 20 | 75 |

| Signal models | | | | |
|---|---|---|---|---|
| Sensor A | Path 1 | Path 2 | Path 3 | Path 4 |
| TxFreq [Hz] | 2.08e+005 | 2.08e+005 | 2.08e+005 | 2.08e+005 |
| TxPeriods [o.E.] | 4 | 4 | 4 | 4 |
| TxPhase [o.E.] | 3 | 3 | 3 | 3 |
| TxDuration [s] | 6e-005 | 6e-005 | 6e-005 | 6e-005 |
| TxDampOut [o.E.] | 60 | 60 | 60 | 60 |
| TxAmplitude [o.E.] | 123 | 123 | 123 | 123 |
| Sensor B | Path 1 | Path 2 | Path 3 | Path 4 |
| TxFreq [Hz] | 2.08e+005 | 2.08e+005 | 2.08e+005 | 2.08e+005 |
| TxPeriods [o.E.] | 4 | 4 | 4 | 4 |
| TxPhase [o.E.] | 3 | 3 | 3 | 3 |
| TxDuration [s] | 6e-005 | 6e-005 | 6e-005 | 6e-005 |
| TxDampOut [o.E.] | 60 | 60 | 60 | 60 |
| TxAmplitude [o.E.] | 123 | 123 | 123 | 123 |
| PostPeriods | PrePeriods 1 | PrePeriods 2 | PrePeriods 3 | PrePeriods 4 |
| +0.5 | +4.0 | +4.0 | +4.0 | +4.0 |
| InitTime [s] | RingOutTime 1 [s] | RingOutTime 2 [s] | RingOutTime 3 [s] | RingOutTime 4 [s] |
| 0.005 | 0.01 | 0.01 | 0.01 | 0.01 |

| Path fail compensation | | | | |
|---|---|---|---|---|
| | Path 1 | Path 2 | Path 3 | Path 4 |
| PathCondStatic | 0.91500 | 1.03000 | 1.03000 | 0.91500 |
| PathCondLow | 1.21943 | 1.17047 | 0.91270 | 0.59108 |
| PathCondHigh | 0.86530 | 1.02933 | 1.05305 | 0.91820 |
| PathCompAverWeight | PathCompClassLo [m/s] | PathCompClassHi [m/s] | PathCompStoreLimit [o.E.] | PathCompValid |
| 0.0001 | 1.0 | 8.0 | 0.005 | 10000 |

| Miscellanous | | | | | |
|---|---|---|---|---|---|
| SystemConfigReg | DOOutputConfigReg | FreqOutputConfigReg | TotalizerResolution [ 1/m³] | MaxVelSound [m/s] | MaxVelGas [m/s] |
| 279B(hex) | 08040110(hex) | 10007003(hex) | 100 | 535.0 | 45.0 |

| AO Adjustment | |
|---|---|
| AOGain [o.E.] | AOOffset [mA] |
| 1.0000 | 0.00000 |

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Fig. 5.21: Example of a configuration protocol (page 3)

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# FLOWSIC600

# Ultrasonic Gas Flow Meter

## Maintenance

General

Routine Checks

Replacing the Transducers

# 6 Maintenance

## 6.1 General

The FLOWSIC600 does not contain mechanically moving parts. Meter body and ultrasonic transducers are the only components that come into contact with the gaseous media. Titanium and high-quality stainless steel ensure that these components are resistant to corrosion, provided that the device is implemented in accordance with the relevant specifications. This means that the FLOWSIC600 is a low-maintenance system. Maintenance is limited mainly to routine checks to determine the plausibility of the measured values and diagnosis results produced by the system (for details see the FLOWSIC600 service manual).

It is recommended to create a diagnosis and status log on a regular basis (see software manual) and compare the information with the initial situation when the system was commissioned. The operating conditions (gas composition, pressure, temperature, flow velocity) of the individual logs should be comparable or documented separately and taken into account when analysing the data.

## 6.2 Routine Checks

You can check the information displayed on the front panel of the of the FLOWSIC600 to ensure that the system is functioning properly.

The routine checks relate to the following values (see also the table below and chapter 6).

**Velocity of sound**

The measured velocity of sound is usually highly stable. Sudden changes in the measured value may hint at signal detection problems, which can affect transit time measurements, or at changes in the gas composition. A theoretical velocity of sound value can be calculated based on the gas composition, pressure and temperature determined during test measurements. Implausible measurements can then be indicated by comparing theoretical and measured velocity of sound and identifying any marked discrepancies. The velocities of sound in the individual paths should also be approximately identical.

**Number of rejected measurements**

The number of rejected measurement (% measuring error) for the measuring path(s) should be as close as possible to 0 %, although this largely depends on the flow velocity. With high flow velocities, the figure can be as high as 50 % without affecting the measuring accuracy. Marked discrepancies in the values under comparable conditions (pressure, temperature, flow velocity, gas composition) indicate that changes have occurred in the device or plant (e.g. disturbance caused by a valve that is not fully open).

**Reception sensitivity (AGC level)**

The reception sensitivity (AGC level) set by the device largely depends on the process pressure. Under normal conditions, this value is highly stable for a long period of time. The difference between the ultrasonic transducers of a measuring path is small, although it can increase with greater velocities. Significant fluctuations in the reception sensitivity indicate a low-quality received signal. A significant increase under comparable process conditions is normally caused by dirt on the ultrasonic transducers (see the service manual for cleaning instructions).


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### Signal-to-noise ratio

These values are generally plant-specific and do not change, provided the conditions remain the same. A reduction in the signal-to-noise ratio while the reception sensitivity stays unchanged hints at sources of acoustic interference (e.g. pressure regulator) near the measuring location.

### Overview of typical values

| | Typical value | Error | Comment |
|---|---|---|---|
| Velocity of sound | Deviation from the theoretical velocity of sound<br>less than ± 0.3 % | Greater than ± 0.3 % | When calculating the theoretical velocity of sound, attention shall be paid to ensuring that the gas composition, pressure and, in particular, temperature at the measuring location are identical to those when the test measurements were conducted. |
| | The differences between the velocities of sound in the individual paths should not exceed ± 1.5 m/s. | Greater than ± 1.5 m/s | Temperature stratification can occur with low flow rates. |
| Signal-to-noise ratio | ~20 dB<br>This depends on the nominal width of the meter body and the current process pressure. | Permanently less than 10 dB | Possible sources of interference include electrical noise caused by bad contact of the connectors or sources of acoustic interference, such as control valves or very high flow velocities. |
| Reception sensitivity / AGC level | This depends on the nominal width of the meter body and the current process pressure. | Significant deviations (greater than 50%) from the historical data with comparable process pressures | The reception sensitivity is inversely proportional to the process pressure: if the pressure doubles, the sensitivity will halve. |
| Number of rejected measurements | < 5 % with zero flow<br>< 35 % with flow | Permanently greater than 50% | |

Deviations from the typical values specified in the table can indicate a malfunction. In addition to diagnosing the error as described in chapter 6, you can also create a diagnosis and status log and send it to SICK MAIHAK for analysis (see software manual).


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## 6.3 Replacing the Transducers

Pairs of ultrasonic transducers may be replaced if necessary. New calibration is not required.

The transducers shall be replaced as described in Section 8.3 of the service manual, and only if the installation is not under pressure. However, if you take advantage of the optional extraction tool, the transducers may also be replaced under process conditions (see extraction tool manual).

After having replaced the transducers, the parameters

- Geometrical length
- Offset time
- Sender model

specified on the check report of the new transducer pair (see Section *9.5.4*) must be entered in the FLOWSIC600. To do so, open the signal processing unit, turn the configuration protection switch to the “open” position (see Section *5.2.6*) and connect the FLOWSIC600 with the MEPAFLOW600 program. Enter the password “Expert” and select the “Service” level in the “Connection” menu (see Section *5.2.4*). Click on the “Device parameters” tab and select the concerned path (see **Fig. 6.1**). Now enter the transducer parameters.

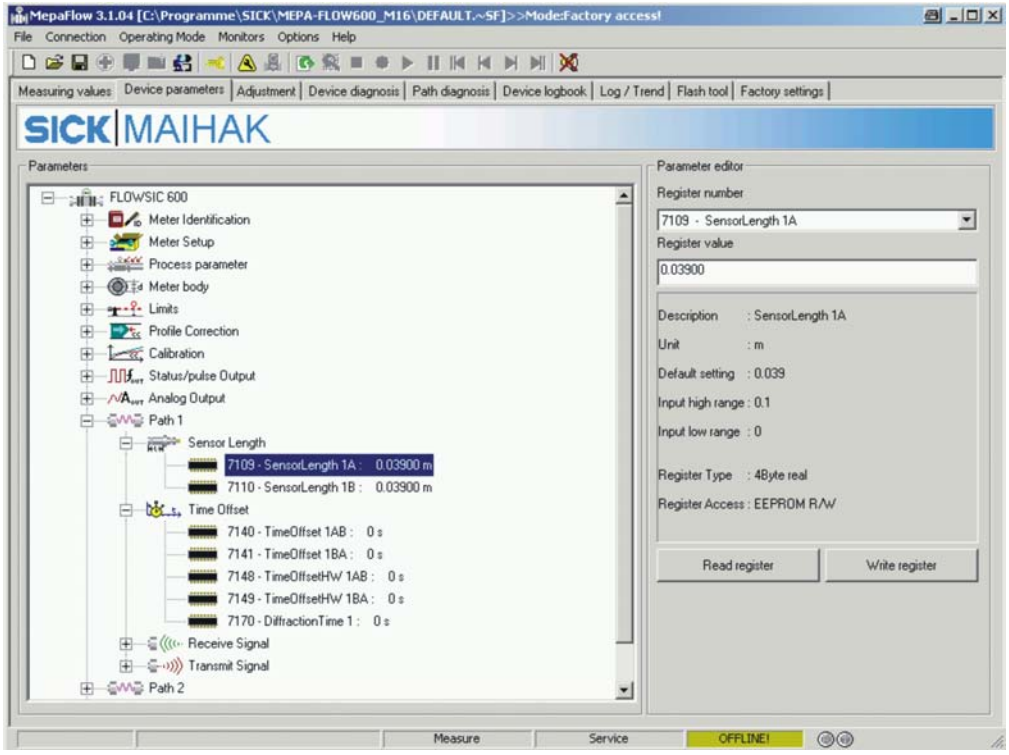


Fig. 6.1: “Device parameters” tab


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Then check the zero phase position of the transducers as described in Section 6.2.1 of the service manual, and optimise it if necessary. Now check the criteria

- Relative variation of the velocities of sound in the individual measuring paths (max. ±0.1 %)
- Absolute variation of the measured velocity of sound compared with the theoretical velocity of sound (max. ±0.3 %)

as described in Section *4.2.3*.

If the FLOWSIC600 or the pipe section in which it is installed can be shut off completely, you should also check the zero point. The path velocity must be less than ± 0.12 m/s. Take into account the effect that possible thermal circulation in the meter body or adjacent pipe section has on the measuring results.

**Sealing**

If the test criteria are fulfilled, you can mount the transducer cover caps. Activate the configuration protection switch, screw on the front cap of the SPU and attach the securing clip. The device must now be sealed as specified in the sealing plan (see Section *9.7*). Attach the test record of the transducer pair installed to the operations data logbook.


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# FLOWSIC600

# Ultrasonic Gas Flow Meter

## Troubleshooting

# 7 Troubleshooting

If the routine tests described in Section *6.2* or the function tests described in Section *4.2.3* indicate that the device is not functioning properly, the following table will help you finding the cause of the fault. If the cause of the fault cannot be localised, the MEPAFLOW600 program can be used to conduct a more detailed fault diagnosis (see software manual, service manual).

| | **Possible cause** | **Corrective action** |
|---|---|---|
| • No display<br>• No pulse frequency<br>• No active status signal | Faulty power supply | • Check the input voltage at terminals 1 and 2<br>• Check cables and terminal connections<br>**Caution**<br>Take the relevant safety precautions! |
| | Defective device | Contact the manufacturer |
| "Warning" on the LC display | Transducer(s) are dirty | Clean the transducer(s) |
| | Transducer(s) are defective | Replace the transducer(s) (see service manual) |
| | Cables mixed up when transducer was cleaned | Check and correct, if necessary |
| Different velocities of sound in the individual paths | Faulty transducer or electronic module | Replace the transducer(s) (see service manual)<br>**Note**<br>Temperature-induced stratification can result in differences between the individual paths, especially with very low flow (higher temperatures generate higher velocities of sound). Even if the plant is being filled or if it is shut down, different velocities of sound may occur in the individual paths as a result of stratification. |
| Implausible velocity of sound | Gas composition, pressure or temperature measurement is incorrect | |
| • Lower signal-to-noise ratio and reception sensitivity<br>• Increased number of rejected measurements in individual paths | Individual transducer(s) damaged during maintenance sctivities | Replace the transducer(s) (see service manual) |
| | Additional sources of noise due to a valve that is not fully open, fittings, noise sources near the device | Check the measurement plausibility and number of rejected measurements and, if necessary, eliminate noise sources. |
| Increased reception sensitivity | Different gas composition or process pressure | No activity required on the device |
| | Transducer(s) are dirty | Clean the transducer(s) |
| Increased number of rejected measurements in all paths | Additional noise sources | Eliminate noise sources |
| | Gas velocity outside the measuring range | |


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# FLOWSIC600

# Ultrasonic Gas Flow Meter

## List of Parts

Tools and Accessories

Spare Parts

# 8 List of parts

## 8.1 Tools and Accessories

| | Part number |
|---|---|
| Transducer extraction tool | 7041772 |
| Special key up to 16 in | 7041872 |
| Special key from 18 in | 4047937 |
| Coax plug-on auxiliary NL200 | 4047938 |
| LCD control set (magnetic pen, adhesive straps) | 2032787 |
| MEPA interface set RS485 / RS232 (Adam, power supply, cable) | 7041773 |
| MEPA interface set RS485 / RS232, intrinsically safe for DIN mounting rail | 6029957 |
| MEPA interface set RS485 / USB (converter, cable, plug, software) | 6030669 |
| MEPAFLOW600 | 7048511 |


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## 8.2 Spare Parts

### SPU housing and electronic module

| | Part number |
|---|---|
| Power supply terminal box cover with seal | 7041671 |
| Set of clips (for SPU housing rear cover and front panel) | 2031000 |
| SICK \| MAIHAK LCD front panel | 7041660 |
| Connection block (EMC board and backplane) | 2040275 |
| Fuse board with parts needed for assembly | 2039149 |
| Electronic block IIA/D 135 kHz (power, SPU, I/O, analogue) | 2040382 |
| Electronic block IIC/BCD 135 kHz (analogue board and shunt board) | 2040383 |
| Electronic block IIA/D H 135 kHz (analogue board and shunt board) | 2040384 |
| Electronic block IIC/BCD H 135 kHz (analogue board and shunt board) | 2040385 |
| Electronic block IIA/D 200 kHz (analogue board and shunt board) | 2040386 |
| Electronic block IIC/BCD 200 kHz (analogue board and shunt board) | 2040387 |
| Electronic block IIA/D H 200 kHz (analogue board and shunt board) | 2040388 |
| Electronic block IIC/BCD H 200 kHz (analogue board and shunt board) | 2040389 |
| Buffer battery | 7048533 |

### Ultrasonic transducers

| | Part number |
|---|---|
| Transducer pair, type S1 (200 kHz, 100 bar, 85 °C, titanium, P18) | 7042400 |
| Transducer pair, type S2 (200 kHz, 100 bar, 120 °C, titanium, P18) | 7041787 |
| Transducer pair, type 22 (200 kHz, 250 bar, 120 °C, titanium, P18) | 2039997 |
| Transducer pair, type S6 (200 kHz, 100 bar, 120 °C, titanium, P10) | 7042607 |
| Transducer pair, type 26 (200 kHz, 250 bar, 120 °C, titanium, P10) | 2039441 |
| Transducer pair, type S7 (135 kHz, 16 bar, 180 °C, titanium, P18) | 2040392 |
| Transducer pair, type S8 (135 kHz, 100 bar, 180 °C, titanium, P18) | 2034125 |
| Transducer pair, type 28 (135 kHz, 250 bar, 180 °C, titanium, P18) | 2032538 |
| Transducer pair, type M6 (200 kHz, 10 bar, 120 °C, titanium/+layer, P10) | 2032592 |
| Transducer pair, type L8 (135 kHz, 100 bar, 280 °C, titanium, P18) | 2040394 |
| O ring 15 * 2.0 (Viton, natural gas resistant, -25 ... +200 C) | 7045173 |
| O ring 15 * 2.0 (Viton, LT170-TT, natural gas resistant, -40 ... +200 C) | 5314393 |
| O ring 15 * 2.0 (Celrez, FFKM-900, -15 ...+260 C) | 5315517 |
| O ring 11.5 * 1.5 (Viton, natural gas resistant, -25 ... +200 C) | 5313739 |
| O ring 11.5 * 1.5 (Viton, V747-75, -25 ... +200 C) | 5314241 |
| O ring 11.5 * 1.5 (Celrez, FFKM-900, -15 ...+260 C) | 5314490 |
| O ring 7.5 * 1.5 (Viton, natural gas resistant, -25 ... +200 C) | 7044129 |
| O ring 7 * 2.0 (Viton, LT170-TT, natural gas resistant, -40 ... 200 C) | 5315493 |


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### Other

| | Part number |
|---|---|
| Plug 1/4 in NPT | 7045206 |
| Plug 1/4 in NPT | 5310562 |
| Retaining bolt M27 * 2 | 7041294 |
| Spring washer B12 | 7045991 |
| Retaining bolt M22 * 1.5 | 4040076 |
| Serrated lock washer I 10.5 | 5313750 |
| Retaining bolt M16 * 1.5 | 4039880 |
| Serrated lock washer I 8.2 | 5313705 |
| Sealing cord for cap, 2.0-EPDM (yard ware) | 5308767 |


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# FLOWSIC600

# Ultrasonic Gas Flow Meter

## Appendix

Characteristic Properties and Dimensions of the Meter Body

Operation and Menu Structure of the SPU with LC Display

SPU Terminal Assignment

Device Documentation

FLOWSIC600 Installation Diagrams

Sealing Plan

# 9 Appendix

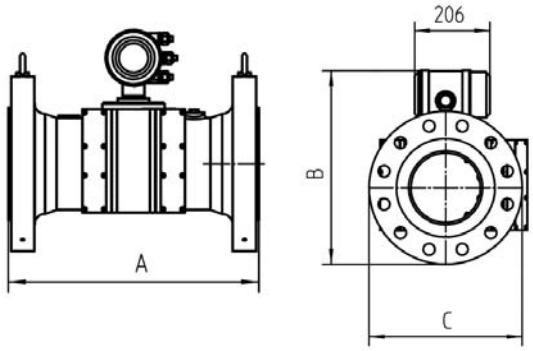
## 9.1 Characteristic Properties and Dimensions of the Meter Body

### Material

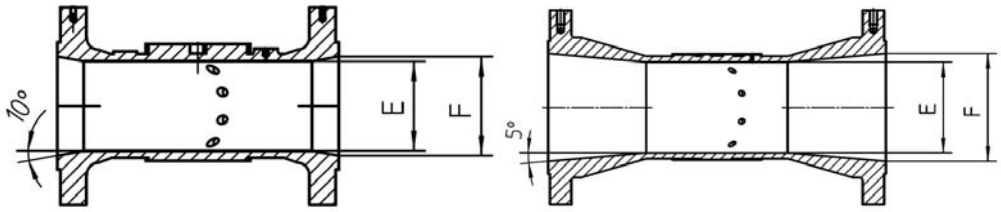
| | | Application |
|---|---|---|
| Carbon steel | 1.1120 (A216 WCC) | Nominal width ≤ DN 600 / NPS 24 |
| | 1.0460 (A105) | Flanges > DN 600 / NPS 24 |
| LT carbon steel | 1.6220 (A352 LCC) | Nominal width ≤ DN 600 / NPS 24 |
| | 1.0566 (A350, LF2 class 1) | Flanges > DN 600 / NPS 24 |
| Stainless steel | 1.4408 (A351 Gr. CF8M) | Nominal width ≤ DN 600 / NPS 24 |
| | 1.4571 (A182 Gr. F316) | Flanges > DN 600 / NPS 24 |
| Duplex | 1.4470 (A995 Gr.4A/UNS J92205) | Nominal width ≤ DN 600 / NPS 24 |
| | 1.4462 (A182 Gr. F51) | Flanges > DN 600 / NPS 24 |

Tab. 9.1: Material

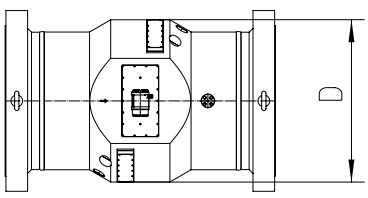
### Weights and dimensions




Model for nominal sizes of 3 ” to 10 ”




Model for nominal sizes of 12 ” to 24 ”




Model for nominal sizes of up to 48 ”

Dimension F must be specified by the customer, as it depends on the internal pipe diameter at the installation location.

Fig. 9.1: Dimensioned drawing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| Nominal pipe size | Connection flange | Standard | Weight | Length (A) | Height (B) | Flange diameter (C) | Width of the measuring section (D) | Internal diameter (E) |
|---|---|---|---|---|---|---|---|---|
| | | | [kg] | mm | mm | mm | mm | mm |
| 2" | cl. 150 | ANSI B16.5 | 28 | 250 | 330 | 152.4 | 160 | 49.3 |
| | cl. 300 | | 29 | 250 | 340 | 165.1 | | 49.3 |
| | cl. 600 | | 30 | 250 | 340 | 165.1 | | 49.3 |
| | cl. 900/ 1500 | | 43 | 300 | 360 | 215.9 | | 42.8 |
| DN50 | PN 16 * | DIN 2633 | 20 | 150 | 345 | - | 155 | 48 |
| | PN 64 | DIN 2636 | 31 | 250 | 345 | 180 | 160 | 49.1 |
| | PN 100 | DIN 2637 | 35 | 250 | 350 | 195 | | 49..1 |
| 3" | cl. 150 | ANSI B16.5 | 33 | 240 | 335.30 | 190.50 | 180 | 73 |
| | cl. 300 | | 34 | | 344.75 | 209.50 | | |
| | cl. 600 | | 38 | | 344.75 | 209.50 | | |
| | cl. 900 | | 76 | 400 | 360.65 | 241.30 | | |
| DN80 | PN 16 | DIN 2633 | 33 | 240 | 340.00 | 200.00 | | |
| | PN 64 | DIN 2636 | 36 | | 347.50 | 215.00 | | |
| | PN 100 | DIN 2637 | 39 | | 355.00 | 230.00 | | |
| 4" | cl. 150 | ANSI B16.5 | 40 | 300 | 389.30 | 228.60 | 240 | 95 |
| | cl. 300 | | 50 | | 402.00 | 254.00 | | |
| | cl. 600 | | 60 | | 411.55 | 273.10 | | |
| | cl. 900 | | 90 | 500 | 421.05 | 292.10 | | |
| DN100 | PN 16 | DIN 2633 | 36 | 300 | 385.00 | 220.00 | | |
| | PN 64 | DIN 2636 | 47 | | 400.00 | 250.00 | | |
| | PN 100 | DIN 2637 | 55 | | 407.50 | 265.00 | | |
| 6" | cl. 150 | ANSI B16.5 | 85 | 450 | 444.70 | 279.40 | 300 | 142 |
| | cl. 300 | | 95 | | 463.75 | 317.50 | | |
| | cl. 600 | | 120 | | 482.80 | 355.60 | | |
| | cl. 900 | | 195 | 750 | 495.50 | 381.00 | | |
| DN150 | PN 16 | DIN 2633 | 80 | 450 | 447.50 | 285.00 | | |
| | PN 64 | DIN 2636 | 100 | | 477.50 | 345.00 | | |
| | PN 100 | DIN 2637 | 115 | | 482.50 | 355.00 | | |
| 8" | cl. 150 | ANSI B16.5 | 130 | 600 | 496.45 | 342.90 | 350 | 190 |
| | cl. 300 | | 160 | | 515.50 | 381.00 | | |
| | cl. 600 | | 190 | | 534.55 | 419.10 | | |
| | cl. 900 | | 270 | | 559.95 | 469.90 | | |
| DN200 | PN 16 | DIN 2633 | 120 | | 495.00 | 340.00 | | |
| | PN 64 | DIN 2636 | 170 | | 532.50 | 415.00 | | |
| | PN 100 | DIN 2637 | 190 | | 540.00 | 430.00 | | |
| 10" | cl. 150 | ANSI B16.5 | 210 | 750 | 543.20 | 406.40 | 410 | 235 |
| | cl. 300 | | 225 | | 562.25 | 444.50 | | |
| | cl. 600 | | 300 | | 594.00 | 508.00 | | |
| | cl. 900 | | 390 | | 613.05 | 546.10 | | |
| DN250 | PN 16 | DIN 2633 | 195 | | 542.50 | 405.00 | | |
| | PN 64 | DIN 2636 | 240 | | 575.00 | 470.00 | | |
| | PN 100 | DIN 2637 | 290 | | 592.50 | 505.00 | | |
| 12" | cl. 150 | ANSI B16.5 | 300 | 900 | 596.30 | 482.60 | 470 | 270 |
| | cl. 300 | | 350 | | 615.35 | 520.70 | | |
| | cl. 600 | | 420 | | 634.40 | 558.80 | | |
| | cl. 900 | | 540 | | 659.80 | 609.60 | | |
| DN300 | PN 16 | DIN 2633 | 275 | | 585.00 | 460.00 | | |
| | PN 64 | DIN 2636 | 370 | | 620.00 | 530.00 | | |
| | PN 100 | DIN 2637 | 460 | | 647.50 | 585.00 | | |

*: Sandwich design (without flanges)


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| Nominal pipe size | Connection flange | Standard | Weight | Length (A) | Height (B) | Flange diameter (C) | Width of the measuring section (D) | Internal diameter (E) |
|---|---|---|---|---|---|---|---|---|
| | | | [kg] | mm | mm | mm | mm | mm |
| 14“ | cl. 150 | ANSI B16.5 | 425 | 1050 | 644.20 | 533.40 | 540 | 315 |
| | cl. 300 | | 525 | | 669.60 | 584.20 | | |
| | cl. 600 | | 595 | | 679.15 | 603.30 | | |
| | cl. 900 | | 760 | | 698.15 | 641.30 | | |
| DN350 | PN 16 | DIN 2633 | 420 | | 637.50 | 520.00 | | |
| | PN 64 | DIN 2636 | 550 | | 677.50 | 600.00 | | |
| | PN 100 | DIN 2637 | 680 | | 705.00 | 655.00 | | |
| 16" | cl. 150 | ANSI B16.5 | 560 | 1200 | 699.45 | 596.90 | 570 | 360 |
| | cl. 300 | | 630 | | 724.85 | 647.70 | | |
| | cl. 600 | | 790 | | 743.90 | 685.80 | | |
| | cl. 900 | | 1060 | | 753.40 | 704.80 | | |
| DN400 | PN 16 | DIN 2633 | 520 | | 691.00 | 580.00 | | |
| | PN 64 | DIN 2636 | 670 | | 736.00 | 670.00 | | |
| | PN 100 | Dimensions on request | | | | | | |
| 18" | cl. 150 | ANSI B16.5 | 750 | 1350 | 768.50 | 635.00 | 620 | 405 |
| | cl. 300 | | 850 | | 806.60 | 711.20 | | |
| | cl. 600 | | 1000 | | 822.50 | 743.00 | | |
| | cl.900 | | 1400 | | 844.70 | 787.40 | | |
| DN450 | PN 16 | Dimensions on request | | | | | | |
| | PN 64 | | | | | | | |
| | PN 100 | | | | | | | |
| 20“ | cl. 150 | ANSI B16.5 | 940 | 1500 | 800.25 | 698.50 | 670 | 450 |
| | cl. 300 | | 1100 | | 838.35 | 774.70 | | |
| | cl. 600 | | 1235 | | 857.40 | 812.80 | | |
| | cl. 900 | | 1850 | | 879.60 | 857.20 | | |
| DN500 | PN 16 | DIN 2633 | 900 | | 808.50 | 715.00 | | |
| | PN 64 | Dimensions on request | | | | | | |
| | PN 100 | | | | | | | |
| 24" | cl. 150 | ANSI B16.5 | 1425 | 1800 | 907.40 | 812.80 | 760 | 540 |
| | cl. 300 | | 1700 | | 958.20 | 914.40 | | |
| | cl. 600 | | 1900 | | 970.90 | 939.80 | | |
| | cl. 900 | | 2300 | | 1.021.70 | 1.041.40 | | |
| DN600 | PN 16 | DIN 2633 | 1350 | | 921.00 | 840.00 | | |
| | PN 64 | Dimensions on request | | | | | | |
| | PN 100 | | | | | | | |
| 26“ | cl. 150 | ASME B16.47 | 1500 | 1300 | 947.48 | 869.95 | 828 | 585 |
| | cl. 300 | | 1800 | | 1.025.28 | 971.55 | | |
| | cl. 600 | | 2050 | | 1.047.50 | 1.016.00 | | |
| | cl. 900 | | 2500 | | 1.085.85 | 1.085.85 | | |
| DN650 | PN16 | Dimensions on request | | | | | | |
| | PN64 | | | | | | | |
| | PN100 | | | | | | | |
| 28“ | cl. 150 | ASME B16.47 | 1950 | 1400 | 1.028.00 | 927.10 | 862 | 630 |
| | cl. 300 | | 2200 | | 1.081.97 | 1.035.05 | | |
| | cl. 600 | | 2400 | | 1.101.02 | 1.073.15 | | |
| | cl. 900 | | 2900 | | 1.168.40 | 1.168.40 | | |
| DN700 | PN16 | DIN2633 | 1800 | | 1.019.45 | 910.00 | | |
| | PN64 | Dimensions on request | | | | | | |
| | PN100 | | | | | | | |


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| Nominal pipe size | Connection flange | Standard | Weight | Length (A) | Height (B) | Flange diameter (C) | Width of the measuring section (D) | Internal diameter (E) |
|---|---|---|---|---|---|---|---|---|
| | | | [kg] | mm | mm | mm | mm | mm |
| 30“ | cl. 150 | ASME B16.47 | 2250 | 1500 | 1.081.63 | 984.25 | 902 | 675 |
| | cl. 300 | | 2550 | | 1.135.60 | 1.092.20 | | |
| | cl. 600 | | 2800 | | 1.154.65 | 1.130.30 | | |
| | cl. 900 | | 3300 | | 1.231.90 | 1.231.90 | | |
| DN750 | PN16 | Dimensions on request | | | | | | |
| | PN64 | | | | | | | |
| | PN100 | | | | | | | |
| 32“ | cl. 150 | ASME B16.47 | 2625 | 1600 | 1.144.73 | 1.060.45 | 979 | 720 |
| | cl. 300 | | 2950 | | 1.189.18 | 1.149.35 | | |
| | cl. 600 | | 3200 | | 1.211.40 | 1.193.80 | | |
| | cl. 900 | | 3900 | | 1.314.45 | 1.314.45 | | |
| DN800 | PN 16 | DIN2633 | 2450 | | 1.127.00 | 1.025.00 | | |
| | PN 64 | Dimensions on request | | | | | | |
| | PN 100 | | | | | | | |
| 34“ | cl. 150 | ASME B16.47 | 3050 | 1700 | 1.195.13 | 1.111.25 | 1024 | 765 |
| | cl. 300 | | 3430 | | 1.242.75 | 1.206.50 | | |
| | cl. 600 | | 3710 | | 1.261.80 | 1.244.60 | | |
| | cl. 900 | | 4800 | | 1.397.00 | 1.397.00 | | |
| DN850 | PN 16 | Dimensions on request | | | | | | |
| | PN 64 | | | | | | | |
| | PN 100 | | | | | | | |
| 36“ | cl. 150 | ASME B16.47 | 3325 | 1800 | 1.251.20 | 1.168.40 | 1082 | 810 |
| | cl. 300 | | 3700 | | 1.302.00 | 1.270.00 | | |
| | cl. 600 | | 4000 | | 1.324.26 | 1.314.45 | | |
| | cl. 900 | | 5250 | | 1.460.50 | 1.460.50 | | |
| DN900 | PN 16 | DIN2633 | 2750 | | 1.229.50 | 1.125.00 | | |
| | PN 64 | Dimensions on request | | | | | | |
| | PN 100 | | | | | | | |
| 38“ | cl. 150 | ASME B16.47 | 4135 | 1900 | 1.308.63 | 1.238.25 | 1160 | 855 |
| | cl. 300 | | 4050 | | 1.273.70 | 1.168.40 | | |
| | cl. 600 | | 4575 | | 1.324.50 | 1.270.00 | | |
| | cl. 900 | | 6000 | | 1.460.50 | 1.460.50 | | |
| DN950 | PN 16 | Dimensions on request | | | | | | |
| | PN 64 | | | | | | | |
| | PN 100 | | | | | | | |
| 40“ | cl. 150 | ASME B16.47 | 4375 | 2000 | 1.361.53 | 1.289.05 | 1213 | 900 |
| | cl. 300 | | 4650 | | 1.336.13 | 1.238.25 | | |
| | cl. 600 | | 5150 | | 1.377.40 | 1.320.80 | | |
| | cl. 900 | | 6450 | | 1.511.30 | 1.511.30 | | |
| DN1000 | PN 16 | DIN2633 | 4400 | | 1.344.50 | 1.255.00 | | |
| | PN 64 | Dimensions on request | | | | | | |
| | PN 100 | | | | | | | |
| 42“ | cl. 150 | ASME B16.47 | 5150 | 2100 | 1.414.54 | 1.346.20 | 1261 | 945 |
| | cl. 300 | | 5125 | | 1.385.97 | 1.289.05 | | |
| | cl. 600 | | 5850 | | 1.443.12 | 1.403.35 | | |
| | cl. 900 | | 7150 | | 1.562.10 | 1562.10 | | |
| DN1050 | PN 16 | Dimensions on request | | | | | | |
| | PN 64 | | | | | | | |
| | PN 100 | | | | | | | |


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| Nominal pipe size | Connection flange | Standard | Weight | Length (A) | Height (B) | Flange diameter (C) | Width of the measuring section (D) | Internal diameter (E) |
|---|---|---|---|---|---|---|---|---|
| | | | [kg] | mm | mm | mm | mm | mm |
| 44“ | cl. 150 | ASME B16.47 | 5925 | 2200 | 1.468.68 | 1.403.35 | 1310 | 990 |
| | cl. 300 | | 5900 | | 1.443.28 | 1.352.55 | | |
| | cl. 600 | | 6600 | | 1494.08 | 1.454.15 | | |
| | cl. 900 | | 8200 | | 1.647.95 | 1.647.95 | | |
| DIN1100 | PN 16 | Dimensions on request | | | | | | |
| | PN 64 | | | | | | | |
| | PN 100 | | | | | | | |
| 48“ | cl. 150 | ASME B16.47 | 7075 | 2400 | 1.573.65 | 1.511.30 | 1416 | 1080 |
| | cl. 300 | | 7150 | | 1.551.43 | 1.466.85 | | |
| | cl. 600 | | 8100 | | 1.614.96 | 1.593.85 | | |
| | cl. 900 | | 9400 | | 1.784.35 | 1.784.35 | | |
| DN1200 | PN 16 | DIN2633 | 6600 | | 1.560.50 | 1.485..00 | | |
| | PN 64 | Dimensions on request | | | | | | |
| | PN 100 | | | | | | | |

Tab. 9.2: Meter dimensions

| | Pipe dimensions in accordance with ANSI B36.10M - 1985 | | | | | DIN 2633 | DIN 2636 | DIN 2637 |
|---|---|---|---|---|---|---|---|---|
| | SC20 | SC30 | SC40 | SC60 | SC80 | PN16 | PN64 | PN100 |
| 2" | | | 52.5 | | 49.3 | | | |
| DN 50 | | | | | | 54.5 | 54.5 | 54.5 |
| 3" | | | | | | | | |
| | | | | | | | 81.5 | 80.9 |
| 4" | | | 102.3 | | 97.2 | | | |
| DN 100 | | | | | | 107.1 | 106.3 | 104.3 |
| 6" | | | | | | | | |
| | | | | | | | 157.1 | 154.1 |
| 8" | 206.4 | 205 | 202.7 | 198.5 | 193.7 | | | |
| DN 200 | | | | | | 206.5 | 204.9 | 199.1 |
| 10" | 260.4 | 257.5 | 254.5 | 247.7 | 242.9 | | | |
| | | | | | | | 255.4 | 248.0 |
| 12" | 311.2 | 307.1 | 303.2 | 295.3 | 288.9 | | | |
| DN 300 | | | | | | 309.7 | 301.9 | 295.5 |
| 14“ | 339.8 | 336.6 | 333.3 | 325.4 | 317.5 | | | |
| | | | | | | | 343.0 | 336.0 |
| 16" | 390.6 | 387.4 | 381.0 | 373.1 | 363.5 | | | |
| DN 400 | | | | | | 390.4 | 378 | |
| | 441.4 | 434.9 | 428.7 | 419.1 | 409.5 | | | |
| | | | | | | | | |
| 20“ | 489.0 | 482.6 | 477.8 | 466.8 | 455.6 | | | |
| DN 500 | | | | | | 492.0 | | |
| | 590.6 | 581.1 | 574.6 | 560.4 | 547.7 | | | |
| | | | | | | | | |

Tab. 9.3: Inner pipe diameter


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## 9.2 Operation and Menu Structure of the SPU with LC Display

### 9.2.1 Operation

The current measured values, counter readings, and diagnosis information can be displayed on the two-line LC display on the front panel of the SPU. The information you want to be displayed can be selected using a magnetic pen, while the front cap is kept closed, or using the buttons while the front cap is open (see **Fig. 9.2**).

ATTENTION

**Important**

EMC and protection from accidental contact cannot be guaranteed if the cover is opened.

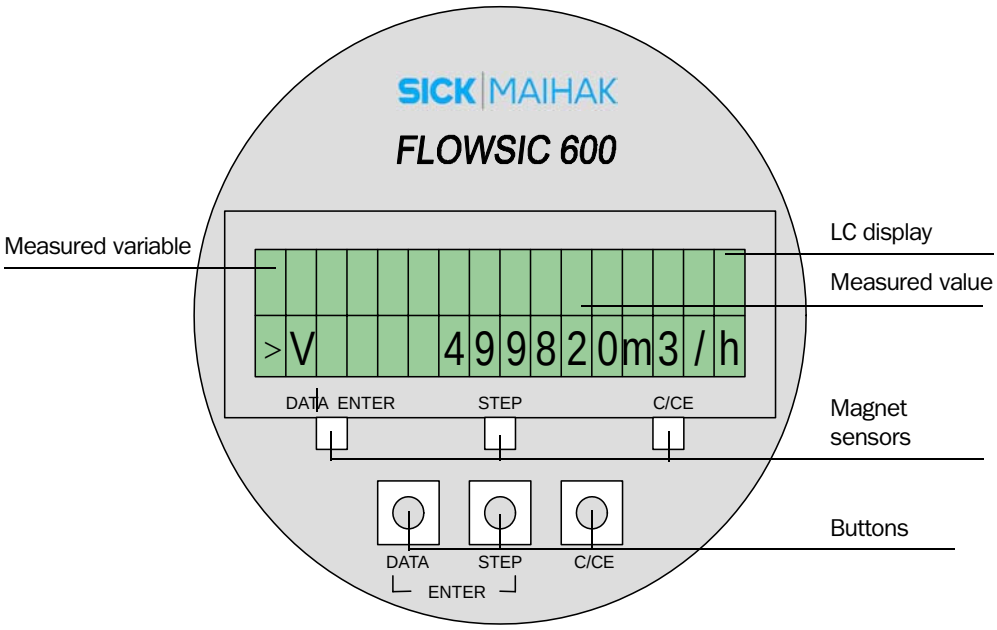


Fig. 9.2: Front panel with LC display

The buttons have the following functions:

| | **Function** |
|---|---|
| C/CE | In a menu, to go back one level and, finally, to return to the measured value display. |
| STEP | To go forward in the menu. |
| DATA | To go back in the menu. |

**ENTER function**

To select a menu level, to acknowledge logbook entries and to reset the error volume counters. If ENTER is pressed after selection of a modifiable parameter (and if the configuration protection is disabled), this parameter can be edited (see Section *9.2.4*).

- Magnetic pen operation:
  Activate the DATA/ENTER button for > 2s.
- Button operation:
  Press STEP and DATA simultaneously, or press DATA for > 2 s.


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### 9.2.2 Menu structure

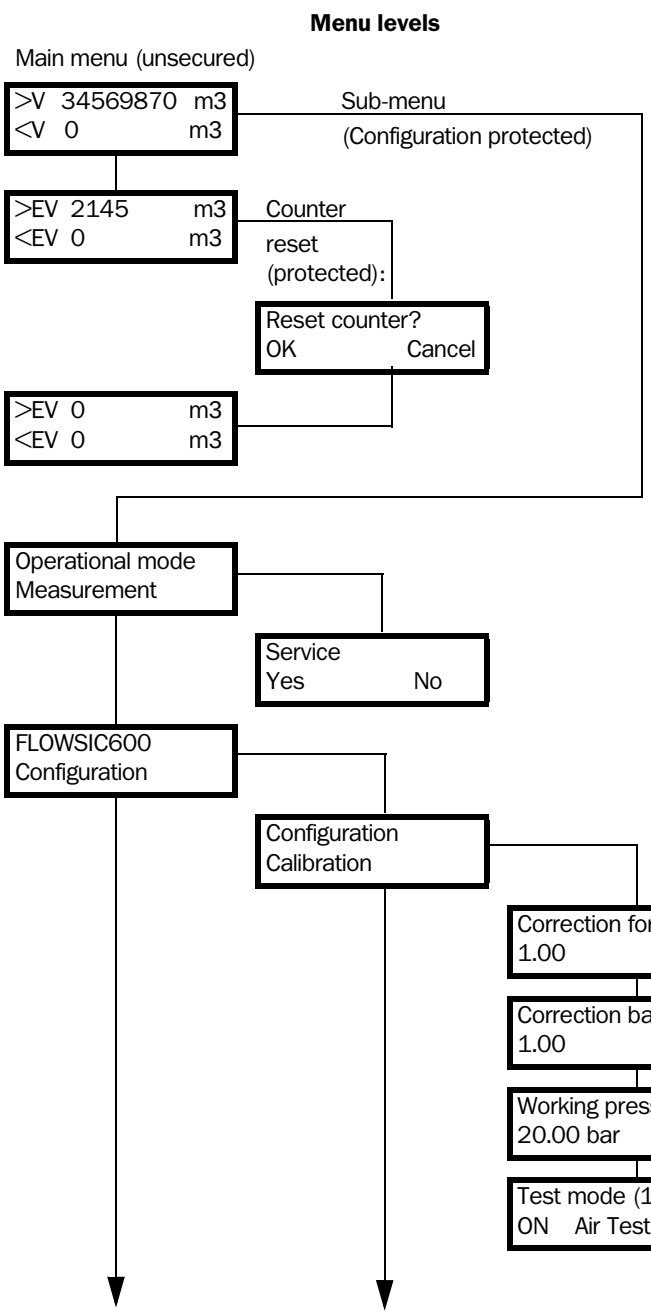
The display menu allows you to call up topically structured information, acknowledge logged events and reset the error volume counters, using the buttons described above. The overview below shows all possible displays.

**Notes** Parameters can only be entered or edited after having switched to the Service mode.

Meaning of the connection lines in the menu structure below:

– Vertical lines: to go forward (STEP button) or back (DATA button)

– Horizontal lines: ENTER function to change to lower-level menu, C/CE button to change to higher-level menu




**Notes**

Indication of the current operating volume counter readings for each direction of flow (first line: positive direction, second line: negative direction).

Indication of the current error volume counter readings for each direction of flow (top line: positive direction, bottom

After selection of the desired display, activate the ENTER function. A confirmation dialog will appear.

Activate the ENTER function again to reset the error volume counter to zero. This event will be recorded in the logbook together with the time stamp. To cancel the reset, press C/CE.

Indication of the current operational mode

To switch the operational mode between Measurement and Service.

To display and edit the system configuration for commissioning and parameterisation.

To enter the basic parameters for calibration of the meter according to the field conditions.

To display and configure the forward correction factor.

To display and configure the backward correction factor.

The parameters pe_min and pe_max will be calculated from the entered average working pressure.

To turn on/off the calibration mode

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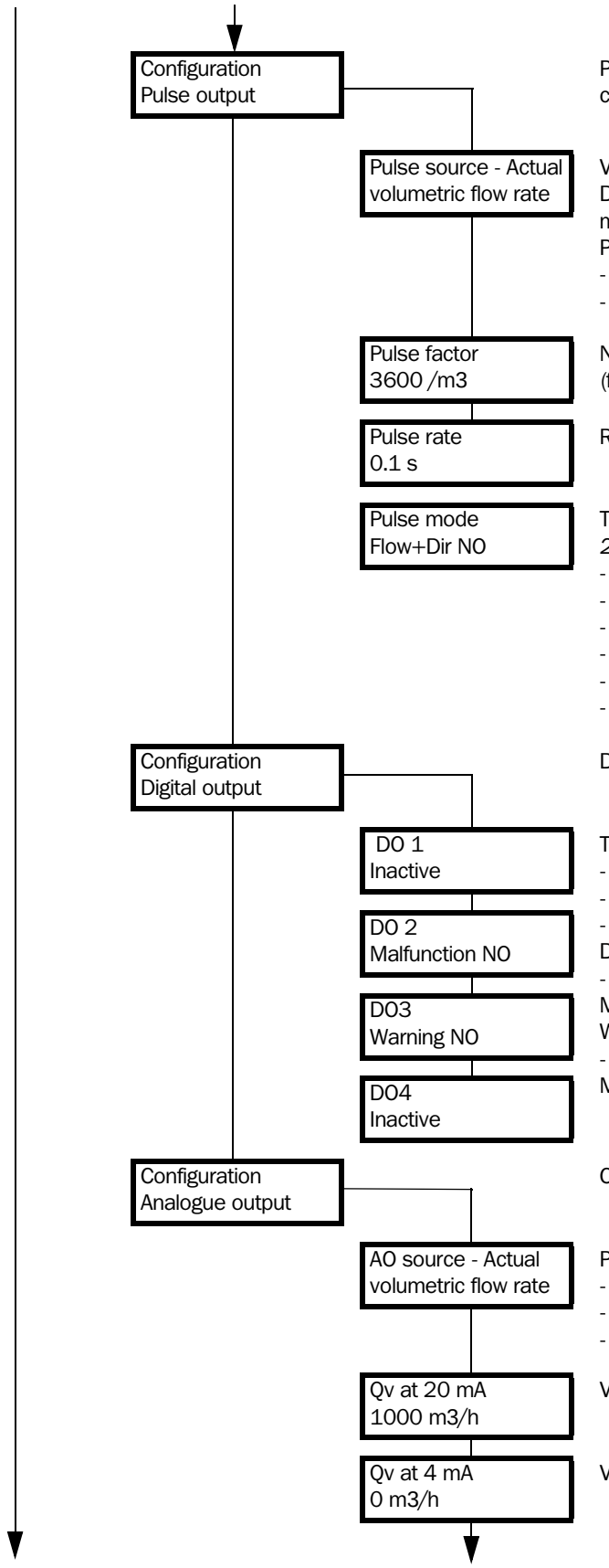



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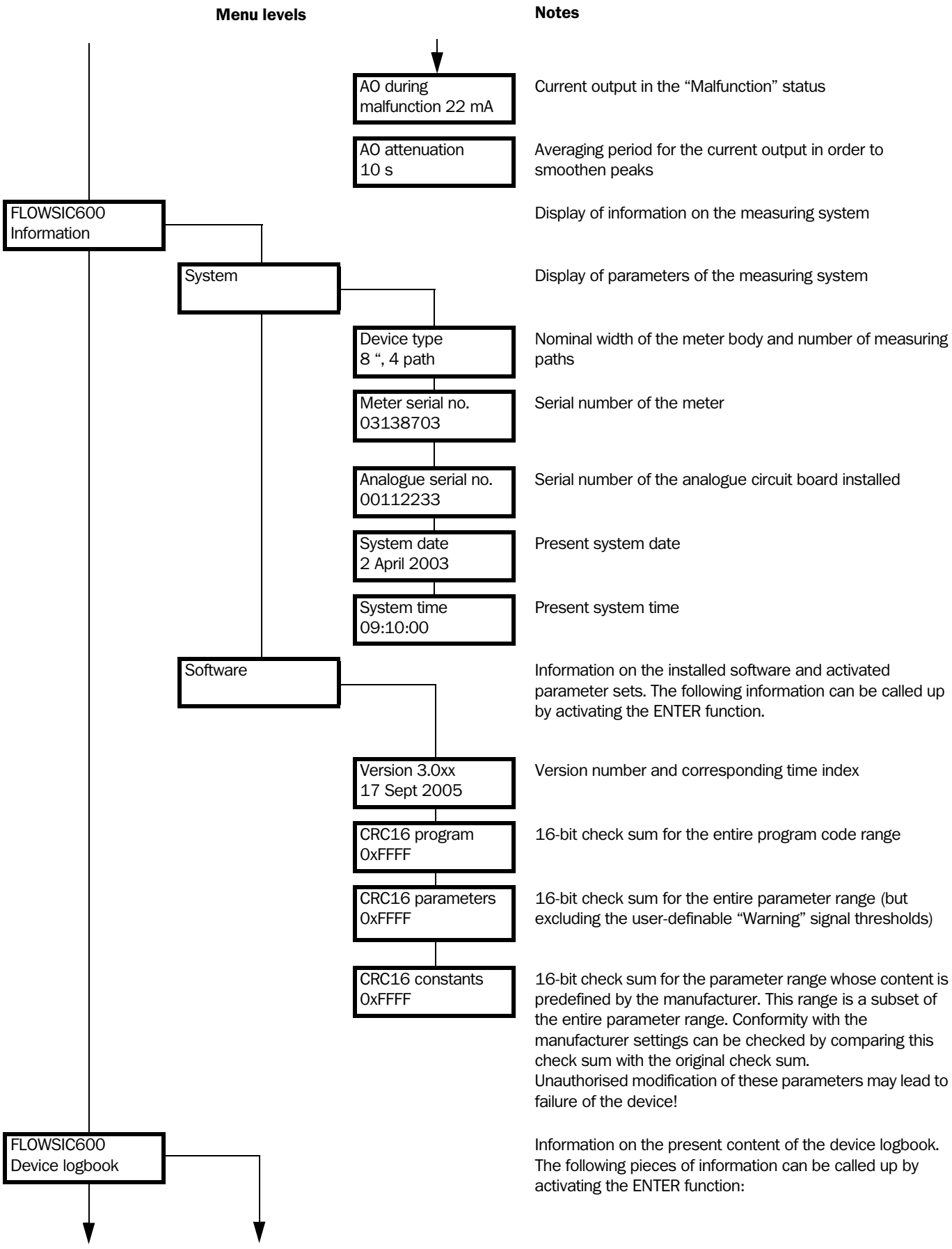
Menu levels
Notes
AO during malfunction 22 mA
Current output in the “Malfunction” status
AO attenuation 10 s
Averaging period for the current output in order to smoothen peaks
FLOWSIC600 Information
Display of information on the measuring system
System
Display of parameters of the measuring system
Device type 8 “, 4 path
Nominal width of the meter body and number of measuring paths
Meter serial no. 03138703
Serial number of the meter
Analogue serial no. 00112233
Serial number of the analogue circuit board installed
System date 2 April 2003
Present system date
System time 09:10:00
Present system time
Software
Information on the installed software and activated parameter sets. The following information can be called up by activating the ENTER function.
Version 3.0xx 17 Sept 2005
Version number and corresponding time index
CRC16 program 0xFFFF
16-bit check sum for the entire program code range
CRC16 parameters 0xFFFF
16-bit check sum for the entire parameter range (but excluding the user-definable “Warning” signal thresholds)
CRC16 constants 0xFFFF
16-bit check sum for the parameter range whose content is predefined by the manufacturer. This range is a subset of the entire parameter range. Conformity with the manufacturer settings can be checked by comparing this check sum with the original check sum.
Unauthorised modification of these parameters may lead to failure of the device!
FLOWSIC600 Device logbook
Information on the present content of the device logbook. The following pieces of information can be called up by activating the ENTER function:

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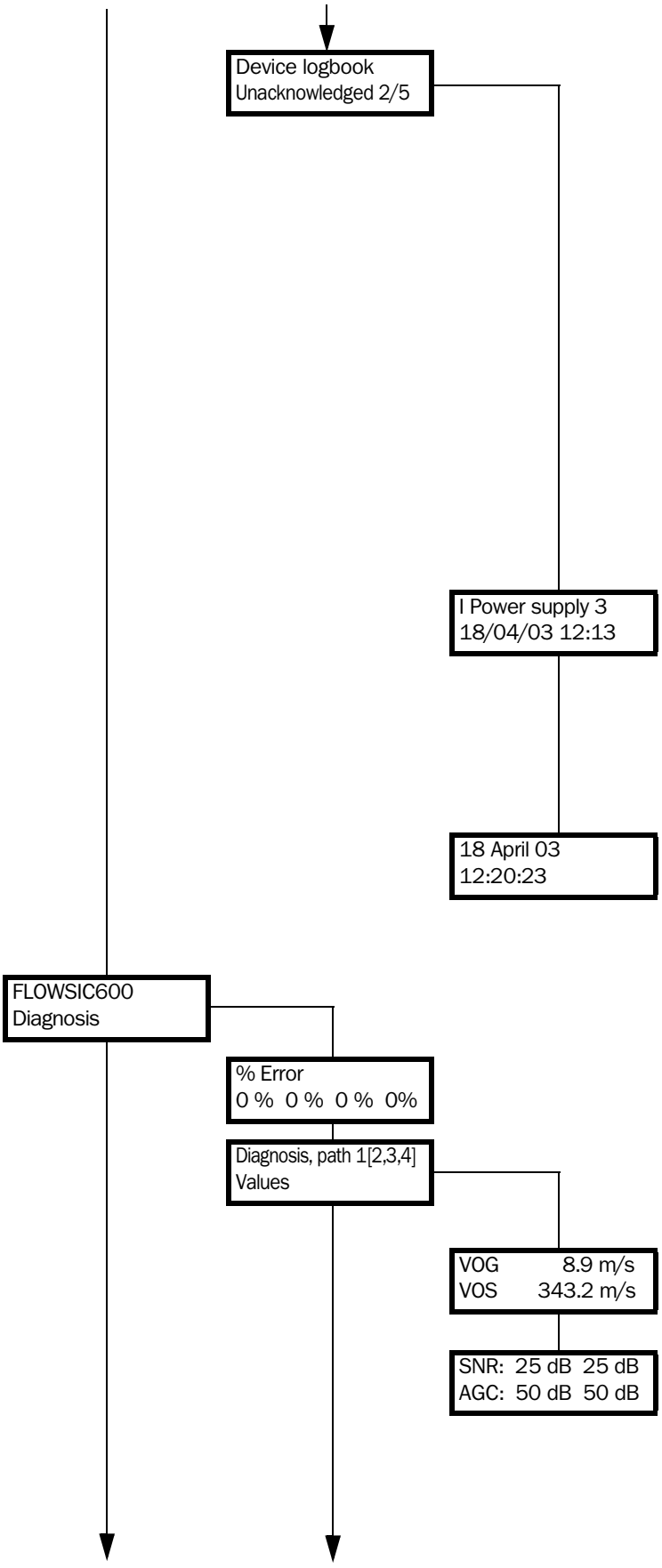


**Notes**

Display of the total number of saved logbook entries and of the number of those entries which have not yet been acknowledged
Example:
Five entries were recorded, two have not been acknowledged.
To select the individual entries, activate the ENTER function. The most recent entry is shown first. Press DATA to jump forward and STEP to jump backward in the list of entries. Entries which have not been acknowledged are identified by a flashing display.
To acknowledge a logbook entry:

- Go to the unacknowledged entry using the DATA or STEP button.
- Activate the ENTER function to show the corresponding time stamp (display is still flashing).
- Activate the ENTER function again in order to acknowledge the entry (display will stop flashing).
- Return to the list of logbook entries by pressing C/CE.

The classification and type of event, the position in the list of entries and the type of occurrence are always shown in the first line. Further information may be shown in the second line, depending on the type of entry. Activate the ENTER function to display the time stamp of the event. Return to the list of logbook entries by pressing C/CE.

Example:

Failure of the power supply on 18 April 2003 at 12:13. Activate the ENTER function to display the time stamp of the event. In the present case it is the time from which the measuring system was available again (18 April 2003, 12:20).

FLOWSIC600 system diagnosis

Display of the ratio of incorrect and correct measurements.

Display of further information on path x (x = 1 to 4) Activate the ENTER function to call up the following information:

Display of the actual values of flow rate (velocity of gas, VOG) and velocity of sound (VOS) in path x

Display of the actual signal-to-noise ratio (SNR) and reception sensitivity (automatic gain control, AGC) in path x, one value for each direction of measurement (left: along with the gas flow, right: against the gas flow)


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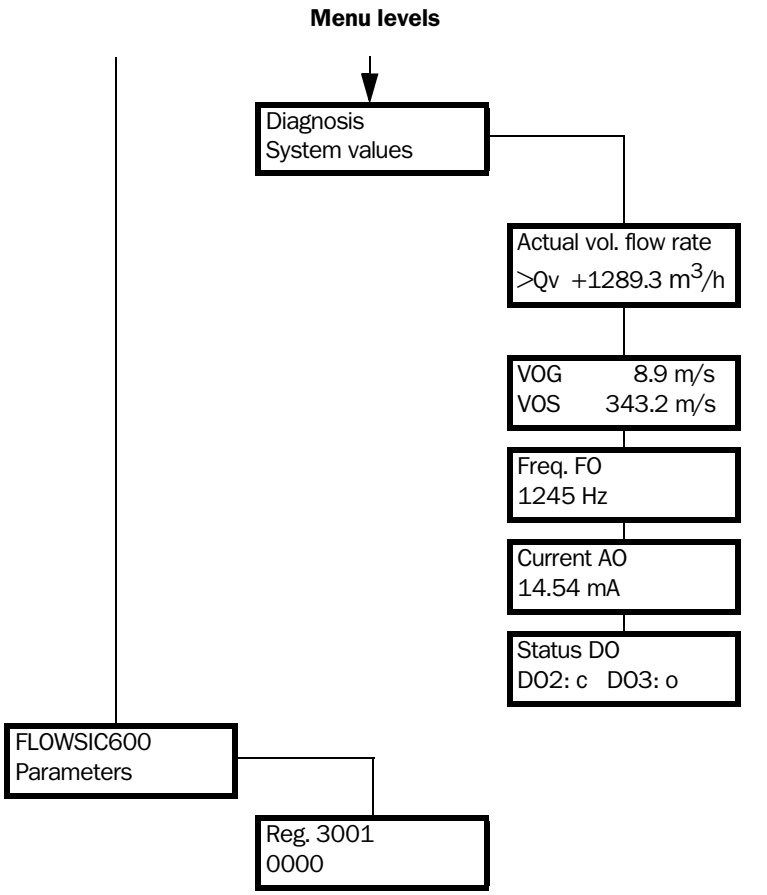
Menu levels
Notes
Diagnosis
System values
Display of further system information Activate the ENTER function to call up the following information:
Actual vol. flow rate
>Qv +1289.3 m3/h
Display of the actual volumetric flow rate together with the direction of flow (positive direction marked by ">Qv" and +, negative direction marked by "<Qv" and –)
VOG 8.9 m/s
VOS 343.2 m/s
Display of the actual measured values of flow velocity (first line) and velocity of sound (second line)
Freq. FO
1245 Hz
Display of the actual frequency at the frequency output
Current AO
14.54 mA
Display of the actual current at the analogue output
Status DO
DO2: c DO3: o
Display of the current status of the digital switching output (c: closed, o: open)
FLOWSIC600
Parameters
FLOWSIC600 system diagnosis
Reg. 3001
0000
Display of all registers stored in the device. Press STEP or DATA to navigate in the list of registers.

### 9.2.3 Display of measured values

See software manual

The indicated measured values can be assigned individually to either line of the display. Take advantage of the MEPAFLOW600 program to make this assignment. In addition, both display lines may be given an alternative assignment (second content). If the multiplex configuration is active, the two display contents are shown alternately (display changes every 5 s).

### 9.2.4 Editing mode

It is possible in this mode to modify parameters which are relevant for commissioning. To be able to do so, the configuration protection switch must be open. Select the parameter and activate the ENTER function.

Options depending on the type of data:

- Integer: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, sign
- Floating point: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, space, decimal point, sign
- List of registers: List of all registers (which are plausible for this parameter)

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### Data editing

Entering or editing data will be explained with the help of the following example.

| Action | Buttons | Display |
|---|---|---|
| Initial display | - | >V 34569870 m3<br><V 0 m3 |
| ↓ Change to the menu | ENTER | FLOWSIC600<br>Configuration |
| ↓ Service/Measurement | 1 x STEP | Service<br>OFF |
| ↓ Change to Service | ENTER –> Change mode<br>ENTER –> Confirm input | Service<br>ON |
| ↓ Scroll to pulse menu | 1 x CE/C<br>2 x STEP | Configuration<br>Pulse output |
| ↓ Select the menu | ENTER | Pulse source<br>Actual vol. flow rate |
| ↓ Change to pulse factor entry | 1 x STEP | Pulse factor<br>1 /m3 |
| ↓ Change to editing mode | ENTER | Pulse factor<br>_ |
| ↓ Enter desired value | STEP, DATA | Pulse factor<br>3 /m3 |
| ↓ Confirm new value | ENTER | Pulse factor<br>Changed value |
| ↓ Exit this menu | 3 x CE/C | >V 34569870 m3<br><V 0 m3 |

## 9.2.5 Definition of logbook entries

**1. Classification**

The entries are distinguished into three classes and identified by the initial character in the first line.

- "I" information
- "W" warning
- "E" error/ malfunction

**2. Type of occurrence**

- "S+" point of time identifying the beginning of a status
- "S-" point of time identifying the end of a status


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### Overview of event entries

| | Class | Explanation | Value |
|---|---|---|---|
| Power on<br>I Power supply<br>18/04/03 12:13 | I | System was cold started or rebooted after a watchdog reset. | Time stamp of the last stored counter reading is considered to be the time of the “Power off” event. |
| Change of operating mode<br>I Operation S+<br>Password 2 | I | System was changed to the configuration mode after password input, or back from the configuration mode to the measurement mode.<br>Parameters that affect the measured values may have been modified. | Activated password level |
| Clock setting<br>I Real time clock<br>18/04/03 12:13 | I | Date and/ or time register of the real time clock was/ were changed. | Time stamp of the register modification |
| Error volume counter reset<br>I Reset EV S+ | I | Error volume counters were reset to zero | Counter reading at the time of the event |
| Counter overflow<br>I Overflow S+ | I | One of the four volume counters has run through completely. | |
| Logbook reset<br>I Reset log S+ | I | Entire logbook was deleted<br>(“Reset” is always the first entry and indicates the point of time the logbook was opened.) | |
| Maintenance required<br>W Service req. S+<br>Path no. | W | The measured value of one path had to be substituted by the replacement value calculation routine. | Path index |
| Output range<br>W Output S+ | W | The current measured value can no longer be represented by the pulse output, because the maximum output frequency was reached. | |
| Measurement invalid<br>E Measurement S+<br>Path | E | More than one path had to be substituted by the replacement value calculation routine, or the adaptive path failure compensation is not yet active. | |
| System error<br>E System S+<br>parameters | E | Reliable operation of the system is not guaranteed. | Cause of the fault<br>• CRC program code<br>• CRC parameters<br>• CRC counter reading<br>• CRC replacement path weights<br>• Parameters (implausible)<br>• DSP |
| Logbook full<br>E System S+<br>Logbook overflow | E | No memory space – further events cannot be logged.<br>The system will turn into the “Malfunction” status. | |


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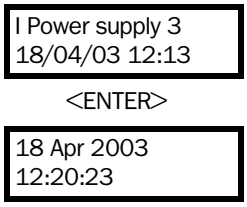
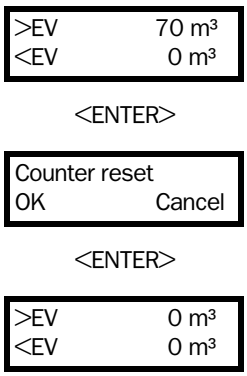
### 9.2.6 Acknowledgement of a logbook entry




Press STEP or DATA to select an entry which has not yet been acknowledged (display is flashing). Activate the ENTER function to display the corresponding time stamp of the event. The display is still flashing. Activate the ENTER function again in order to acknowledge the entry (display will stop flashing). Return to the list of logbook entries by pressing C/CE.

### 9.2.7 Resetting the error volume counters




After having selected the desired display, activate the ENTER function. A confirmation dialog will appear.

Activate the ENTER function again to reset the error volume counter to zero. This event will be recorded in the logbook together with the time stamp.

Press C/CE to cancel the reset.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## 9.3 SPU Terminal Assignment

### Connection in accordance with ATEX IIA

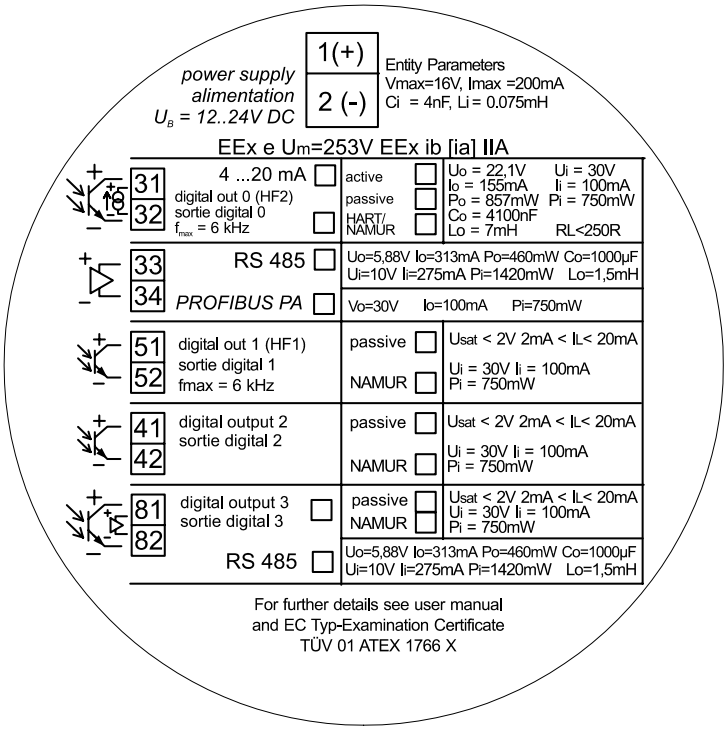


Fig. 9.3: Terminal assignment in accordance with ATEX IIA

### Connection in accordance with ATEX IIC

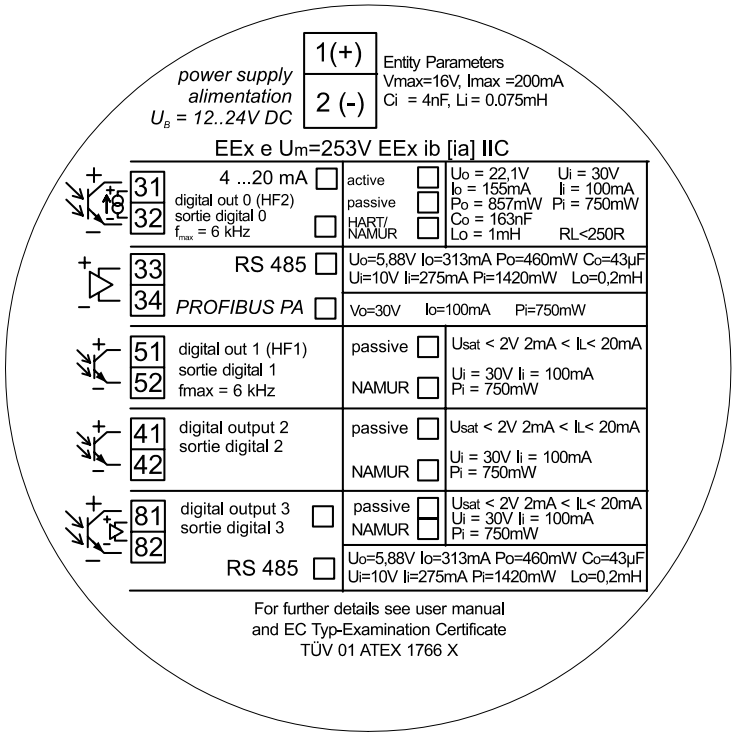


Fig. 9.4: Terminal assignment in accordance with ATEX IIC

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### Connection in accordance with CSA Group B, C, D

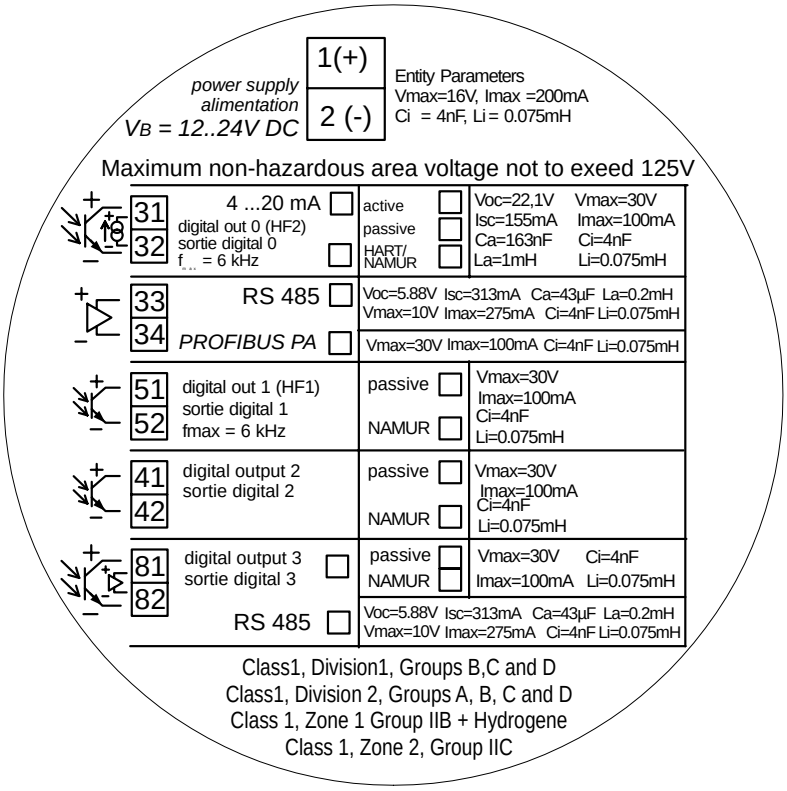


Fig. 9.5: Terminal assignment in accordance with CSA Group B, C, D

### Connection in accordance with CSA Group D

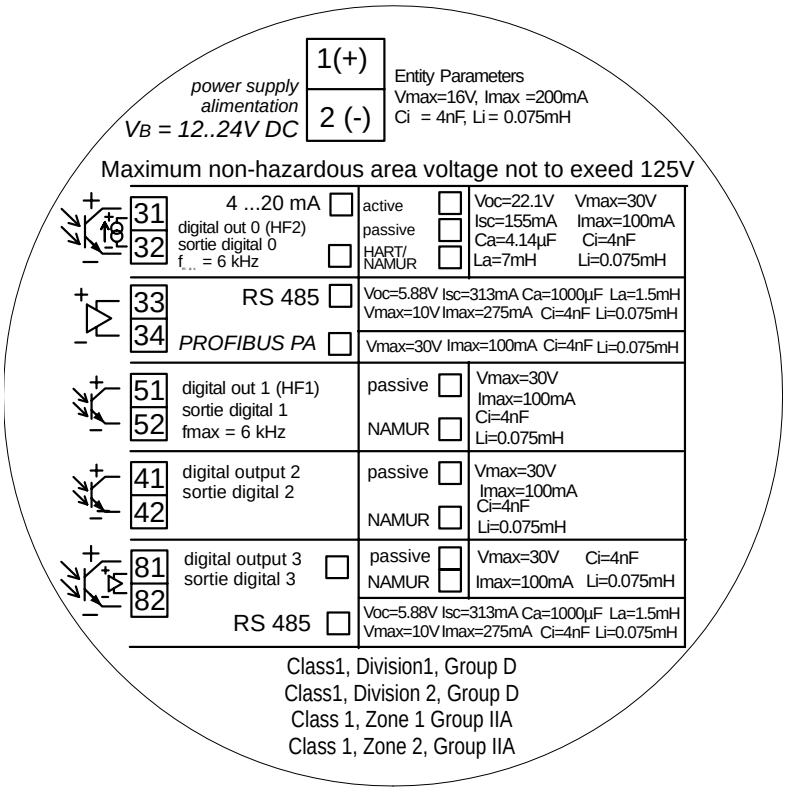


Fig. 9.6: Terminal assignment in accordance with CSA Group D


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## 9.4 Connection Diagrams for Operating the FLOWSIC 600 in Hazardous Areas in Accordance with North American Guidelines (CSA)

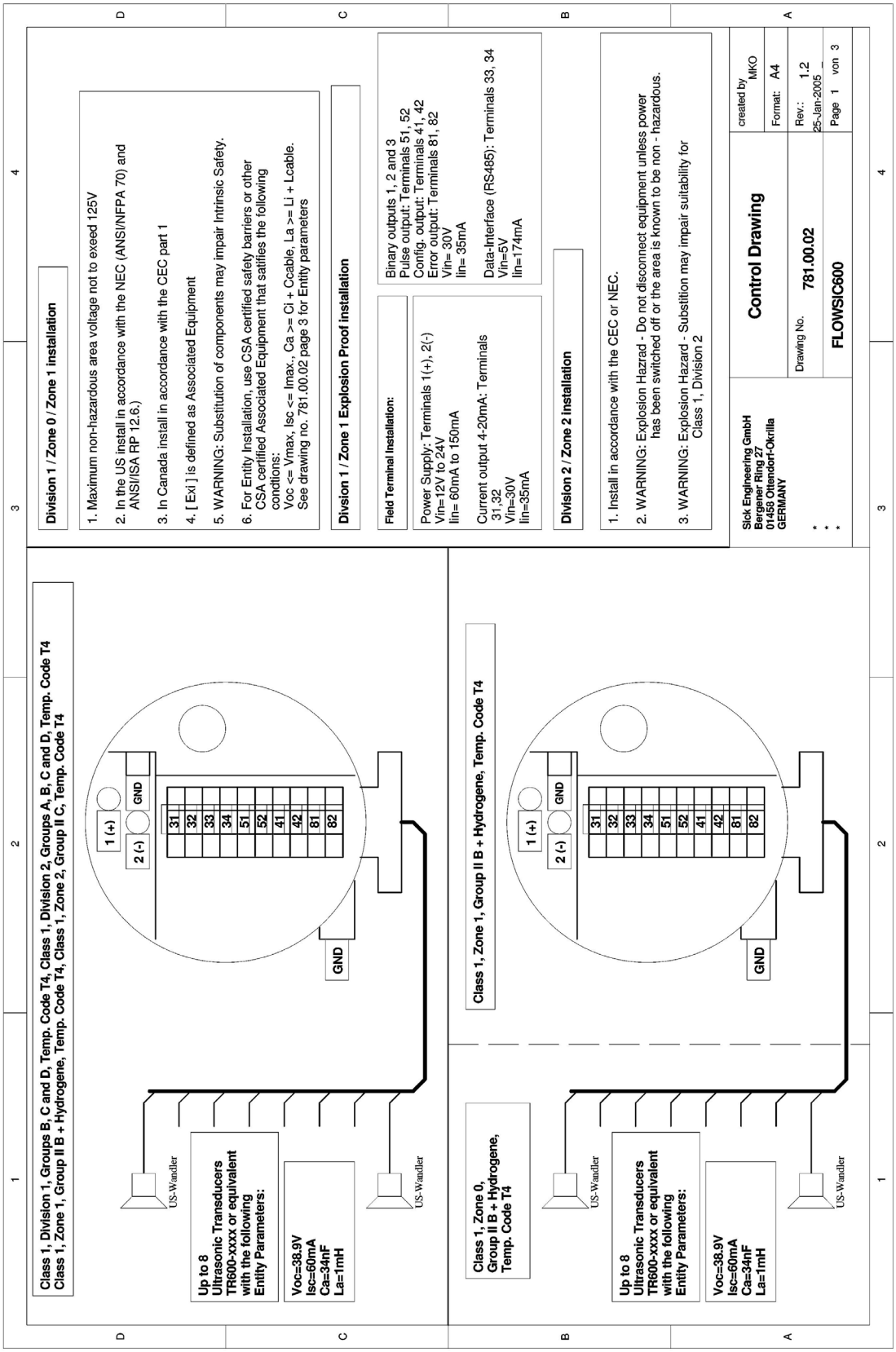
Division 1 / Zone 0 / Zone 1 installation
1. Maximum non-hazardous area voltage not to exeed 125V
2. In the US install in accordance with the NEC (ANSI/NFPA 70) and ANSI/ISA RP 12.6.)
3. In Canada install in accordance with the CEC part 1
4. [ Exi ] is defined as Associated Equipment
5. WARNING: Substitution of components may impair Intrinsic Safety.
6. For Entity Installation, use CSA certified safety barriers or other CSA certified Associated Equipment that satifies the following condtions:
Voc <= Vmax, Isc <= Imax, , Ca >= Ci + Ccable, La >= Li + Lcable.
See drawing no. 781.00.02 page 3 for Entity parameters
Division 1 / Zone 1 Explosion Proof installation
Field Terminal Installation:
Power Supply: Terminals 1(+), 2(-)
Vin= 12V to 24V
Iin= 60mA to 150mA
Current output 4-20mA: Terminals 31,32
Vin=30V
Iin=35mA
Binary outputs 1, 2 and 3
Pulse output: Terminals 51, 52
Config. output: Terminals 41, 42
Error output: Terminals 81, 82
Vin= 30V
Iin= 35mA
Data-Interface (RS485): Terminals 33, 34
Vin=5V
Iin=174mA
Division 2 / Zone 2 installation
1. Install in accordance with the CEC or NEC.
2. WARNING: Explosion Hazrad - Do not disconnect equipment unless power has been switched off or the area is known to be non - hazardous.
3. WARNING: Explosion Hazard - Substition may impair suitability for Class 1, Division 2
Sick Engineering GmbH
Bergener Ring 27
01458 Ottendorf-Okrilla
GERMANY
Control Drawing
Drawing No. 781.00.02
FLOWSIC600
created by MKO
Format: A4
Rev.: 1.2
25-Jan-2005
Page 1 von 3
Class 1, Division 1, Groups B, C and D, Temp. Code T4, Class 1, Division 2, Groups A, B, C and D, Temp. Code T4
Class 1, Zone 1, Group II B + Hydrogene, Temp. Code T4, Class 1, Zone 2, Group II C, Temp. Code T4
1 (+)
2 (-)
GND
31
32
33
34
51
52
41
42
81
82
GND
US-Wandler
Up to 8
Ultrasonic Transducers
TR600-xxxx or equivalent
with the following
Entity Parameters:
Voc=38.9V
Isc=60mA
Ca=34nF
La=1mH
US-Wandler
Class 1, Zone 1, Group II B + Hydrogene, Temp. Code T4
Class 1, Zone 0,
Group II B + Hydrogene,
Temp. Code T4
US-Wandler
Up to 8
Ultrasonic Transducers
TR600-xxxx or equivalent
with the following
Entity Parameters:
Voc=38.9V
Isc=60mA
Ca=34nF
La=1mH
US-Wandler

Fig. 9.7: Control drawing CSA 781.00.02 (page 1)

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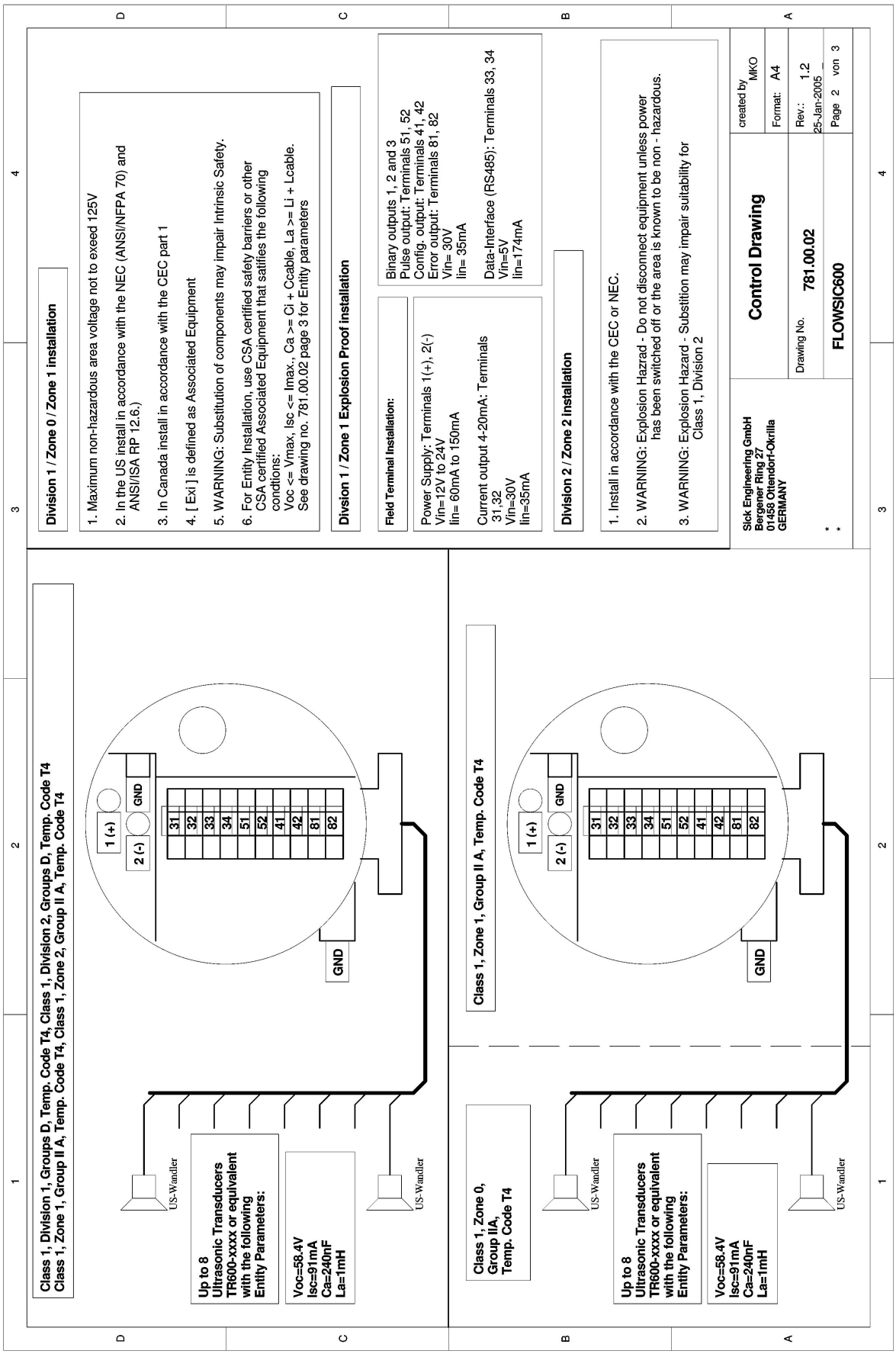
Division 1 / Zone 0 / Zone 1 installation
1. Maximum non-hazardous area voltage not to exeed 125V
2. In the US install in accordance with the NEC (ANSI/NFPA 70) and ANSI/ISA RP 12.6.)
3. In Canada install in accordance with the CEC part 1
4. [ Exi ] is defined as Associated Equipment
5. WARNING: Substitution of components may impair Intrinsic Safety.
6. For Entity Installation, use CSA certified safety barriers or other CSA certified Associated Equipment that satifies the following conditions:
Voc <= Vmax, Isc <= Imax., Ca >= Ci + Ccable, La >= Li + Lcable.
See drawing no. 781.00.02 page 3 for Entity parameters
Division 1 / Zone 1 Explosion Proof installation
Field Terminal Installation:
Power Supply: Terminals 1(+), 2(-)
Vin=12V to 24V
Iin= 60mA to 150mA
Current output 4-20mA: Terminals 31,32
Vin=30V
Iin=35mA
Binary outputs 1, 2 and 3
Pulse output: Terminals 51, 52
Config. output: Terminals 41, 42
Error output: Terminals 81, 82
Vin= 30V
Iin= 35mA
Data-Interface (RS485): Terminals 33, 34
Vin=5V
Iin=174mA
Division 2 / Zone 2 installation
1. Install in accordance with the CEC or NEC.
2. WARNING: Explosion Hazrad - Do not disconnect equipment unless power has been switched off or the area is known to be non - hazardous.
3. WARNING: Explosion Hazard - Substition may impair suitability for Class 1, Division 2
Sick Engineering GmbH
Bergener Ring 27
01458 Ottendorf-Okrilla
GERMANY
Control Drawing
Drawing No. 781.00.02
FLOWSIC600
created by MKO
Format: A4
Rev.: 1.2
25-Jan-2005
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Class 1, Division 1, Groups D, Temp. Code T4, Class 1, Division 2, Groups D, Temp. Code T4
Class 1, Zone 1, Group II A, Temp. Code T4, Class 1, Zone 2, Group II A, Temp. Code T4
1 (+)
2 (-)
GND
31
32
33
34
51
52
41
42
81
82
GND
US-Wandler
Up to 8
Ultrasonic Transducers
TR600-xxxx or equivalent
with the following
Entity Parameters:
Voc=58.4V
Isc=91mA
Ca=240nF
La=1mH
US-Wandler
Class 1, Zone 1, Group II A, Temp. Code T4
Class 1, Zone 0,
Group IIA,
Temp. Code T4
Up to 8
Ultrasonic Transducers
TR600-xxxx or equivalent
with the following
Entity Parameters:
Voc=58.4V
Isc=91mA
Ca=240nF
La=1mH

Fig. 9.8: Control drawing CSA 781.00.02 (page 2)


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## 9.5 Device Documentation

### 9.5.1 Inspection certificate (example)

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**Abnahmeprüfzeugnis / Inspection certificate**
**EN 10204 – 3.1 B**

**Zeugnis Nr. / *Certificate No.* : 427**

**1 Allgemeine Angaben / *General***

| | |
|---|---|
| Kunde / *Customer*: | |
| Bestell-Nr. / *Order No.*: | 30600147 |
| SICK Auftrags-Nr./ *SICK Order No.*: | 912239 |
| Bezeichnung / *Name*: | FLOWSIC600 |
| Typ / *Type*: | FL600-4P3D08CL06000203,2RF0N-S1-3DC1N1Y |
| Serien-Nr./ *Serial No.*: | 06078749 |
| Baujahr / *Year of manufacturing*: | 2006 |
| Max. Betriebsdruck /*Max. operating pressure*: | 100 bar |
| Arbeitstemperatur / *Working temperature*: | Min.: -25°C Max.: 85°C |

**2 Spezifikation Bauteil und Prüfungen / Specification item and tests**

**2.1 Gehäuse / Body**

Abnahmeprüfzeugnis f. Material / *Inspection certificate for material*: 7137 /05B Pos./*Pos.-No.*:0005

| | Werkstoff/*Material*: | Schmelzen-Nr.:/*Heat No.*: |
|---|---|---|
| Messaufnehmer / *meter body*: | GS-20Mn5V | 19821 |

**ND-Prüfungen / *ND tests*:**

| | |
|---|---|
| Magnetpulverprüfung / *Magnetic particle powder* | ☒ |
| Farbeindringprüfung / *Liquid penetration test* | ☐ |
| Ultraschallprüfung / *Ultrasonic inspection* | ☒ |
| Durchstrahlung / *X-ray examination* | ☐ |

| Prüfungen / Tests | Festigkeitsprüfung *Strength test* | Dichtheitsprüfung *Leakage test* |
|---|---|---|
| Kennzeichnung/*Identification*: | 2690 427 | |
| Prüfmedium/*Test medium*: | Wasser/*Water* | - |
| Prüfdruck/*Test pressure*: | 153 bar | - |
| Prüfdauer/*Test duration*: | 30 min | - |

**2.2 Komplettes Messgerät / Assembled measuring device**

| Prüfungen / Tests | Dichtheitsprüfung / *Leakage test* |
|---|---|
| Prüfmedium/*Test medium*: | Luft / Air |
| Prüfdruck/*Test pressure*: | 14,5 bar |
| Prüfdauer/*Test duration*: | 15 min |

Hiermit bestätigen wir, dass an o.g. Bauteil die spezifizierten Prüfungen ohne Beanstandungen durchgeführt wurden.

*We hereby certify, that the specified tests were performed on the above described item without any objections.*

**Qualitätsstelle / Quality Department**

Ort, Datum / *Place,Date* : Ottendorf-Okrilla, 10.04.2006

Unterschrift (Hersteller): i.A.
*Signature (Manufacturer)*:

SICK | MAIHAK
**SICK Engineering GmbH**
Bergener Ring 27
D- 01458 Ottendorf-Okrilla

Doc.-No.: FDB20040054 FLOWSIC600
Rev.: 2.3 vom 23.12.2005

Seite / *Page* 1 von / *of* 1

Fig. 9.9: Inspection certificate (example)


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### 9.5.2 Final check (example)

SICK | MAIHAK

Prüfprotokoll Endprüfung Gaszähler

**Serien-Nr.(serial no):** 06078749 **Ident-Nr.(ident no):** 4427
**Prüfer (approved by):** TH
**Datum (Date):** 4.4.06

**Prüfanweisung**

| | |
|---|---|
| **Hardware** | **Hardware** |
| ♦ MEPA (Service-Modus) starten und Parameterdatei ausdrucken | Start MEPA and print out Configuration Protocol |
| ☑ Überprüfen Typschlüssel mit Gerätekarte | Check Typecode with G-Karte |
| ☑ Prüfen der Kabeldurchführungsgewinde mit dem Typschlüssel (CSA-NPT oder ATEX-M20) | Check cable feed through threat with Kex Code Form |
| ☑ Verwendung von Verschlussstopfen NPT ¼" (Kennzeichnung an der Schlüsselfläche mit NPT ¼") | Check the plug for pressure tap. The plug has to be marked with: NPT ¼" |
| ☑ Überprüfen der Gasgruppe Platine Shunt board mit dem Typschlüssel (ohne, D T4 / IIA, B, C, D T4 / IIC T4) | Check gas group of shunt board against Kex Code Form (without, D T4 /IIA T4, B,C,D T4 / IIC T4) |
| ☑ Überprüfen Impuswertigkeit von Hauptschild und Geräteparameter | Check puls factor with sticker and configured parameter |
| ☑ Speichern der Parameterdatei auf dem Server | Save parameter file at LAN |
| **Durchgeführte Tests / Protokolle vorhanden** | **The following tests are carried out successfully and their protocols are put into the device file** |
| ☑ Wareneingangstest | Meter acceptance test |
| ☑ Nullpunkttest | Zero flow test |
| ☑ Funktionstest | Function test |
| ☑ Flowkalibrierung (Option) | Flow calibration (optional) |
| ☑ Dichtheitstest mit installierten Sonden | Leak test with installed transducers |
| ☑ Isolationstest | Electrical isolation check |
| **Beschriftung** | **Identification** |
| ☑ Aufkleber im Deckel entspricht der richtigen Gasgruppe? | Sticker inside the back cap with correct gas group? |
| ☑ Typschild auf Messumformer? | Type sign is sticked onto the SPU |
| ☑ Klemmen für die Spannungsversorgung mit Aufkleber kennzeichnen | Power terminals labeled |
| ☑ Sicherungsklemmen an den Deckeln montiert | Are the clamps mounted at the caps? |
| **Arbeiten bei eichpflichtigem Gerät** | **Works for Custody Transfer Meters** |
| ☑ Eichpflichtig ? JA / NEIN | Custody transfer YES / NO |
| ☑ Hauptschild auf Messumformer? | Main sign is mounted at the SPU housing |
| ☑ Brücke für Parameterschutz gesteckt? Park pos. | Locking jumper for parameter access denial is set |
| ☑ Plombenschrauben an den Sicherungsklemmen vorn und hinten? | Locking screws at the front cap and the back cap are used |
| ☐ Plombenschrauben an den Sondendeckeln | Locking screws at the meter caps are used |
| **Registration** | **Registration** |
| ☑ Seriennummer ist in der Gerätekarte eingetragen | Serial No. Is written down in the ‚G-Karte' |
| ☑ Gerätekarte auf Vollständigkeit überprüfen | The ‚G-Karte' is checked to be complete |
| ☑ Gerätebegleitkarte vollständig ausgefüllt | The ‚G-Karte' is filled in |
| ☑ Geräteakte komplett / Vollständigkeit Protokolle | The meter file is complete |
| ☑ Vergleich Typschild mit den Daten in der Gerätekarte/Auftragsdaten | Compare original sticker with device map |
| ☑ Vergleich Typschild mit den Daten in der Gerätekarte/Auftragsdaten | |

Ident-Nr.: FDB20020103 Revision: 1.5 01.12.2005 SICK Engineering GmbH
Produktgruppe: FLOWSIC600 Seite 1 / 2

Fig. 9.10: Final check, sheet 1 (example)


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## Prüfprotokoll Endprüfung Gaszähler

**Prüfanweisung**

| Kundendokumentation[1] | Copy the following protocols and assemble them for delivery to the customer |
|---|---|
| ☒ Gerätekonfigurationsblatt (1 Seite) | Device Configuration Sheet |
| ☒ Nullpunkttest Protokoll (1 Seite) | Zero Flow Protocol |
| ☒ MEPA Konfigurationsprotokoll (2 Seiten) | MEPA configuration protocol |
| ☒ Original SICK-Maihak Zertifikat 3.1b (1Seite) | Original SICK-Maihak Inspection Certificate |
| ☒ Kopie Material Abnahmeprüfzeugnis (3 Seiten) | Copy of Material Inspection Certificate of Casting |
| ☒ Konformitätserklärung nach PED DGRL 97/23/EWG (1Seite) | EC declaration of conformity acc. PED DGRL 97/23/EWG |
| ☒ Konformitätserklärung nach NSP 73723/EWG, EMV 89/336/EWG, 94/9/EG (1 Seite) | EC declaration of conformity acc. NSP 73723/EWG, EMV 89/336/EWG, 94/9/EG |
| ☒ Zertifikat CSA (4 Seiten) | Certificate of Compliance by CSA |
| ☒ Baumusterprüfzeugnis (4 Seiten) | EC Type-Examination Certificate |
| ☐ Bedienungsanleitung (Normal oder PTB version) gemäß Auftrag | User Manual (Normal or PTB version) |
| ☒ Prüfprotokoll Endprüfung Gaszähler ausgefüllt und unterschrieben | Finally this complete filled and signed protocol |
| ☒ MEPA-Handbuch und CD-ROM in SlimeCase | MEPA manual and disks |
| ☒ Bei LCD-Ausführung: Hinweisblatt LCD-Bedienset in Kundendokumentation | |

Kundendokumentation zusammengestellt und überprüft:

Datum: 19.4.2006 Signum: J.A. Eus

**Der Gaszähler mit der o.g. Serien-Nr. wurde überprüft und kalibriert nach unseren QS-Standards basierend auf ISO9001. Dieses Gerät erfüllt oder übererfüllt alle angegebenen Spezifikation.**

**The gas counter with the above notified Serial No. Has been checked and calibrated according our QS standards which are based on ISO9001. This flow meter meets or exeeds all published specifications.**

[1] Nichtzutreffendes durchstreichen!

Ident-Nr.: FDB20020103 Revision: 1.5 01.12.2005 SICK Engineering GmbH

Produktgruppe: FLOWSIC600 Seite 2 / 2

Fig. 9.11: Final check, sheet 2 (example)

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### 9.5.3 Check report SPU (example)

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**Elektronik/Electronic**
**Prüfschein / Check report**

**Analogplatinennummer/Analoge board no.:**
2005420165

**Seriennummer/Seriel number:**
06020023

**Variante Ex-Barriere/Ex proved:**
ATEX IIA

**Durchgeführte Tests/Checks**

☐ Prüfen Barrierenspannung/EX voltage check
☐ Referenzlaufzeitmessung/Reference check
☐ Funktionstest/Function check

**Messwerte/Measuring values**
**Referenzlaufzeitmessung/Reference check**

| | | Pfad 1/Path 1 | Pfad 2/Path 2 | Pfad 3/Path 3 | Pfad 4/Path 4 |
|---|---|---|---|---|---|
| Elektronik Zeitoffset [s]/ Electronic time offset | AB | -2,757E-07 | -2,772E-07 | -2,821E-07 | -2,772E-07 |
| | BA | -2,748E-07 | -2,762E-07 | -2,813E-07 | -2,784E-07 |
| Diffraction time [s] | Wert [s] | 5,300E-07 | 5,100E-07 | 5,100E-07 | 5,300E-07 |

**Elektronikparameter/Electronic parameter**

| | | Pfad 1/Path 1 | Pfad 2/Path 2 | Pfad 3/Path 3 | Pfad 4/Path 4 |
|---|---|---|---|---|---|
| HW Zeitoffset AB*/ HW Time offset AB* | Register # | 7148 | 7150 | 7152 | 7154 |
| | Wert [s] | 2,543E-07 | 2,328E-07 | 2,279E-07 | 2,528E-07 |
| HW Zeitoffset BA*/ HW Time offset BA* | Register # | 7149 | 7151 | 7153 | 7155 |
| | Wert [s] | 2,552E-07 | 2,338E-07 | 2,287E-07 | 2,516E-07 |

Die Funktion des Gerätes wurde unter o. g. Bedingungen nachgewiesen.

31.3.06
(Datum/Date)

i.A.
(Prüfer/Approved by)

Eingebaut in Gaszähler Seriennummer/
Used in device with serial number: 06078749

*) Der zu setzende Parameter "TimeOffsetHW" (Register #7148...#7155) ergibt sich als Summe aus Zeitoffset Laufzeitreferenz und nennweitenabhängigen Zeitoffset Diffractioneffekt.
*) Parmeter "TimeOffsetHW" (Register #7148...#7155) is calculated as summary with Electronic

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Fig. 9.12: Check report SPU (example)


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### 9.5.4 Check report transducer pair (example)

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**Prüfschein/Check report**
**Sondenpaar 1/Transducer pair 1**

| | | | |
|---|---|---|---|
| **Sondentyp/Transducer type:** | S1 | **SendemodellTransmit model:** | |
| | | Sendefrequenz [Hz]/Tx Freque | 208000 |
| **Sondenseriennummer/Serial number:** | | Anzahl Gesamtperioden/Tx Pe | 4 |
| | | Anz. ungebremste Perioden/T: | 3 |
| Seriennummer Sonde A/Serial number A: | 05470078 | | |
| Seriennummer Sonde B/Serial number B: | 05470055 | **Durchgeführte Tests/Reports:** | |
| | | ☒ Muttertest/Master check | |
| **Geometrische Länge/Transducer length:** | | ☒ Laufzeittest gegen Referenzelektronik/ Reference check | |
| Länge Sonde A [m]/Transducer length A [m]: | 0,038994 | | |
| Länge Sonde B [m]/Transducer length B [m]: | 0,039006 | | |
| **Offsetzeit/Time offset:** | | | |
| Zeit Sonde A [s]/Timeoffset AB: | 1,73975E-05 | | |
| Zeit Sonde B [s]/Timeoffset BA: | 1,74007E-05 | | |

(Prüfer/Approved)

10.04.06
(Datum/Date)

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Fig. 9.13: Check report transducer pair, sheet 1 (example)

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**Prüfschein/Check report**
**Sondenpaar 2/Transducer pair 2**

| | |
|---|---|
| **Sondentyp/Transducer type:** | S1 |
| **Sondenseriennummer/Serial number:** | |
| Seriennummer Sonde A/Serial number A: | 05470093 |
| Seriennummer Sonde B/Serial number B: | 05470057 |
| **Geometrische Länge/Transducer length:** | |
| Länge Sonde A [m]/Transducer length A [m]: | 0,03903375 |
| Länge Sonde B [m]/Transducer length B [m]: | 0,039001 |
| **Offsetzeit/Time offset:** | |
| Zeit Sonde A [s]/Timeoffset AB: | 1,74835E-05 |
| Zeit Sonde B [s]/Timeoffset BA: | 1,74831E-05 |

**SendemodellTransmit model:**

| | |
|---|---|
| Sendefrequenz [Hz]/Tx Freque | 208000 |
| Anzahl Gesamtperioden/Tx Pe | 4 |
| Anz. ungebremste Perioden/T: | 3 |

**Durchgeführte Tests/Reports:**

☒ Muttertest/Master check

☒ Laufzeittest gegen Referenzelektronik/ Reference check

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10.04.06
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Fig. 9.14: Check report transducer pair, sheet 2 (example)


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**Prüfschein/Check report**
**Sondenpaar 3/Transducer pair 3**

| | |
|---|---|
| **Sondentyp/Transducer type:** | S1 |
| **Sondenseriennummer/Serial number:** | |
| Seriennummer Sonde A/Serial number A: | 05470175 |
| Seriennummer Sonde B/Serial number B: | 05470064 |
| **Geometrische Länge/Transducer length:** | |
| Länge Sonde A [m]/Transducer length A [m]: | 0,038992 |
| Länge Sonde B [m]/Transducer length B [m]: | 0,038982 |
| **Offsetzeit/Time offset:** | |
| Zeit Sonde A [s]/Timeoffset AB: | 1,73440E-05 |
| Zeit Sonde B [s]/Timeoffset BA: | 1,73457E-05 |

**Sendemodell/Transmit model:**

| | |
|---|---|
| Sendefrequenz [Hz]/Tx Freque | 208000 |
| Anzahl Gesamtperioden/Tx Pe | 4 |
| Anz. ungebremste Perioden/T: | 3 |

**Durchgeführte Tests/Reports:**

☒ Muttertest/Master check

☒ Laufzeittest gegen Referenzelektronik/ Reference check

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Fig. 9.15: Check report transducer pair, sheet 3 (example)


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**Prüfschein/Check report**
**Sondenpaar 4/Transducer pair 4**

| | |
|---|---|
| **Sondentyp/Transducer type:** | S1 |
| **Sondenseriennummer/Serial number:** | |
| Seriennummer Sonde A/Serial number A: | 05470090 |
| Seriennummer Sonde B/Serial number B: | 05470071 |
| **Geometrische Länge/Transducer length:** | |
| Länge Sonde A [m]/Transducer length A [m]: | 0,03898325 |
| Länge Sonde B [m]/Transducer length B [m]: | 0,038986 |
| **Offsetzeit/Time offset:** | |
| Zeit Sonde A [s]/Timeoffset AB: | 1,73488E-05 |
| Zeit Sonde B [s]/Timeoffset BA: | 1,73503E-05 |

**Sendemodell/Transmit model:**

| | |
|---|---|
| Sendefrequenz [Hz]/Tx Freque | 208000 |
| Anzahl Gesamtperioden/Tx Pe | 4 |
| Anz. ungebremste Perioden/T: | 3 |

**Durchgeführte Tests/Reports:**

☒ Muttertest/Master check

☒ Laufzeittest gegen Referenzelektronik/ Reference check

(Prüfer/Approved)

10.Okt.06
(Datum/Date)

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Fig. 9.16: Check report transducer pair, sheet 4 (example)


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### 9.5.5 Zero flow protocol (example)

## Zero Flow Protocol

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Ottendorf-Okrilla / Germany

| | |
|---|---|
| Device SN | 06078749 |
| Analogboard SN | 2005420165 |
| Electronicblock SN | 06020023 |

| | | | |
|---|---|---|---|
| **Device** | FLOWSIC 600 | **Date** | 31.03.2006 |
| **Type** | FL600-4P3D08CL06000203.1RF0N-S1-3DC1N1Y | **Operator** | TMI |
| **Path number** | 4 | **File name** | zerologging_427 |
| **Laboratory** | SICK Dresden | **Log time [min]** | 15 |

### Test conditions

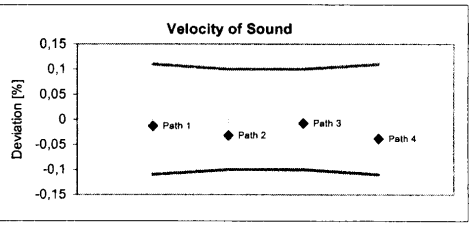
| Test Gas | rel. Humidity | Temp. [°C] | Pressure [bara] | Theoretical VOS [m/s] |
|---|---|---|---|---|
| Ambient air | 34% | 23,1 | 0,985 | 345,70 |

### Velocity of sound check

| max. permissible VoS Deviation [%] | max. permissible VoS Path Spread [m/s] |
|---|---|
| 0,2 | 0,5 |

**Measuring values**

| | VOS [m/s] | Diff. to theor. [%] | Result |
|---|---|---|---|
| **Path 1** | 345,657 | -0,013 | ok |
| **Path 2** | 345,594 | -0,032 | ok |
| **Path 3** | 345,677 | -0,008 | ok |
| **Path 4** | 345,571 | -0,038 | ok |
| **Maximum** | 345,677 | 0,11 | ok |
| **Minimum** | 345,571 | | |

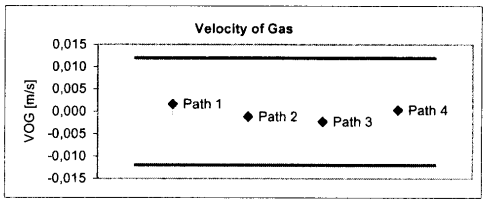



### Velocity of gas check

| max. Error VOG [m/s] | 0,012 |
|---|---|

**Measuring values**

| | VOG [m/s] | Result |
|---|---|---|
| **Path 1** | 0,002 | ok |
| **Path 2** | -0,001 | ok |
| **Path 3** | -0,002 | ok |
| **Path 4** | 0,000 | ok |
| **Maximum** | 0,002 | 0,004 |
| **Minimum** | -0,002 | |




### Diagnosis Values

| | SNR [dB] up | SNR [dB] down | AGC [dB] up | AGC [dB] down | %Error |
|---|---|---|---|---|---|
| **Path 1** | 38,9 | 38,9 | 55,0 | 55,0 | 0 |
| **Path 2** | 38,3 | 38,3 | 58,9 | 58,9 | 0 |
| **Path 3** | 38,4 | 38,5 | 59,0 | 58,9 | 0 |
| **Path 4** | 38,9 | 38,9 | 54,9 | 55,0 | 0 |

Date : 31.3.06 Approved by: i.A.

Delaytimes

04.04.2006
10:57 Rev. 2.0 G_Karte_427_Rev_108

Fig. 9.17: Zero flow protocol, sheet 1 (example)

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### 9.5.6 Check report leak test (example)

## Prüfprotokoll Dichtheitstest Gaszähler

**Serien-Nr.**(serial no): 00743449 **Ident-Nr.**(ident no): 427
**Prüfer** (approved by): IST
**Datum** (Date): 30.03.06

**Prüfanweisung**

Der Test prüft die Dichtheit der eingesetzten Sensoren. In diesem Test wird die Druckänderung (P3) im Inneren der Abdeckkappen gemessen.

Purpose of the test is to detect if there are any leakages at the transducer sealings. For this test the pressure (P3) inside the mounted testing caps will be observed and compared with ambient pressure.

### Durchführung Unterdrucktest

- ♦ Starten mit dem Unterdrucktest, P2 in Tabelle Unterdrucktest eintragen
- ☒ Nach dem Abwarten der Haltezeit P2 in Tabelle eintragen und Abweichung kontrollieren

### Procedure of Underpressure Test

Start the underpressure leak check, note P2 in the table „Underpressure Test"
Wait .....

### Durchführung Dichtheitstest

- ☒ Sichtprüfung der Dichtflächen des Flansches und der Dichtung
- ♦ Verschließen des Gaszählers mit Blindflanschdeckeln
- ♦ Montieren der Testkappen
- ♦ Anschließen des Druckanschlusses an den Gaszähler
- ☒ Prüfen des Betriebsdrucks auf dem Messaufnehmer
- ♦ Füllen des Messaufnehmers mit Druckluft gemäß Gerätekarte Spezifikation
- ☒ Sicherstellen das P1 während der Haltezeit den Sollwert hält
- ☒ Haltezeit gemäß Gerätekarte Spezifikation abwarten und P3 in die Tabelle eintragen

### Procedure of Leakage Test

Visual check of flange sealing faces and gaskets

Block the pressure tap at the meter body
Block the meter body with blind flanges
Mount the testing caps
Check the design pressure of the meter body
Fill the meter body with pressurized air up to ....

Make shure that P1 is at least ..... during the leakage test

Wait .... , then record P3 again to the table

### Unterdrucktest

Umgebungstemp. 23,5 °C

| Dichtheitstest / Leakage Test | P3 [mbar] |
|---|---|
| $t_0$ | 462 |
| $t_0$ + Haltezeit/Time 2 min | 464 |
| Abweichung / Difference | 2 |

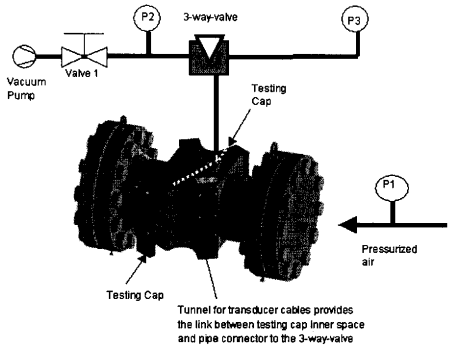
☒ Test o.k., wenn ΔP2 < 5mbar

### Dichtheitstest

P1(Prüfdruck) 1115 bar
Umgebungstemp. 23,2 °C
Umgebungsdruck 985 mbar

| Dichtheitstest / Leakage Test | P3 [mbar] |
|---|---|
| $t_0$ | 0 |
| $t_0$ + Haltezeit/Time 15 min | 0,24 |
| Abweichung / Difference | 0,24 |

☒ Test o.k., wenn ΔP3 < 2mbar




Ident-Nr.: FDB20020104
Produktgruppe: FLOWSIC600

Revision: 1.4 03.03.2005

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Fig. 9.18: Check report leak test (example)


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## 9.6 FLOWSIC600 Installation Diagrams

### 9.6.1 Intrinsically safe installation

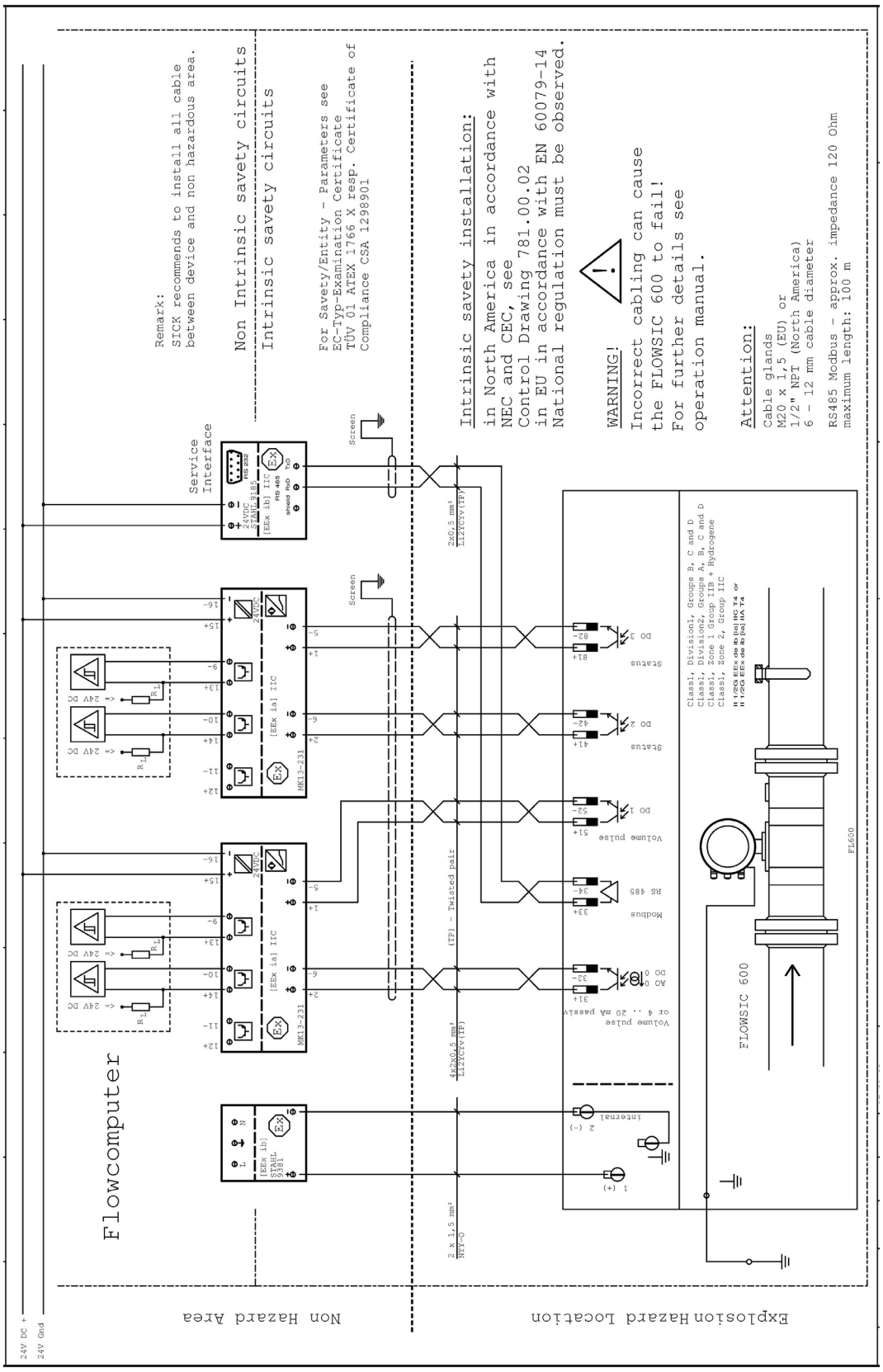
Remark:
SICK recommends to install all cable between device and non hazardous area.
Non Intrinsic savety circuits
Intrinsic savety circuits
For Savety/Entity - Parameters see EC-Typ-Examination Certificate TÜV 01 ATEX 1766 X resp. Certificate of Compliance CSA 1298901
Intrinsic savety installation:
in North America in accordance with NEC and CEC, see Control Drawing 781.00.02
in EU in accordance with EN 60079-14 National regulation must be observed.
WARNING!
Incorrect cabling can cause the FLOWSIC 600 to fail!
For further details see operation manual.
Attention:
Cable glands
M20 x 1,5 (EU) or
1/2" NPT (North America)
6 - 12 mm cable diameter
RS485 Modbus - approx. impedance 120 Ohm
maximum length: 100 m
Service Interface
Screen
Flowcomputer
FLOWSIC 600
Non Hazard Area
Explosion Hazard Location
24V DC +
24V Grd

Fig. 9.19: FLOWSIC600 intrinsically safe installation

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### 9.6.2 Non-intrinsically safe installation

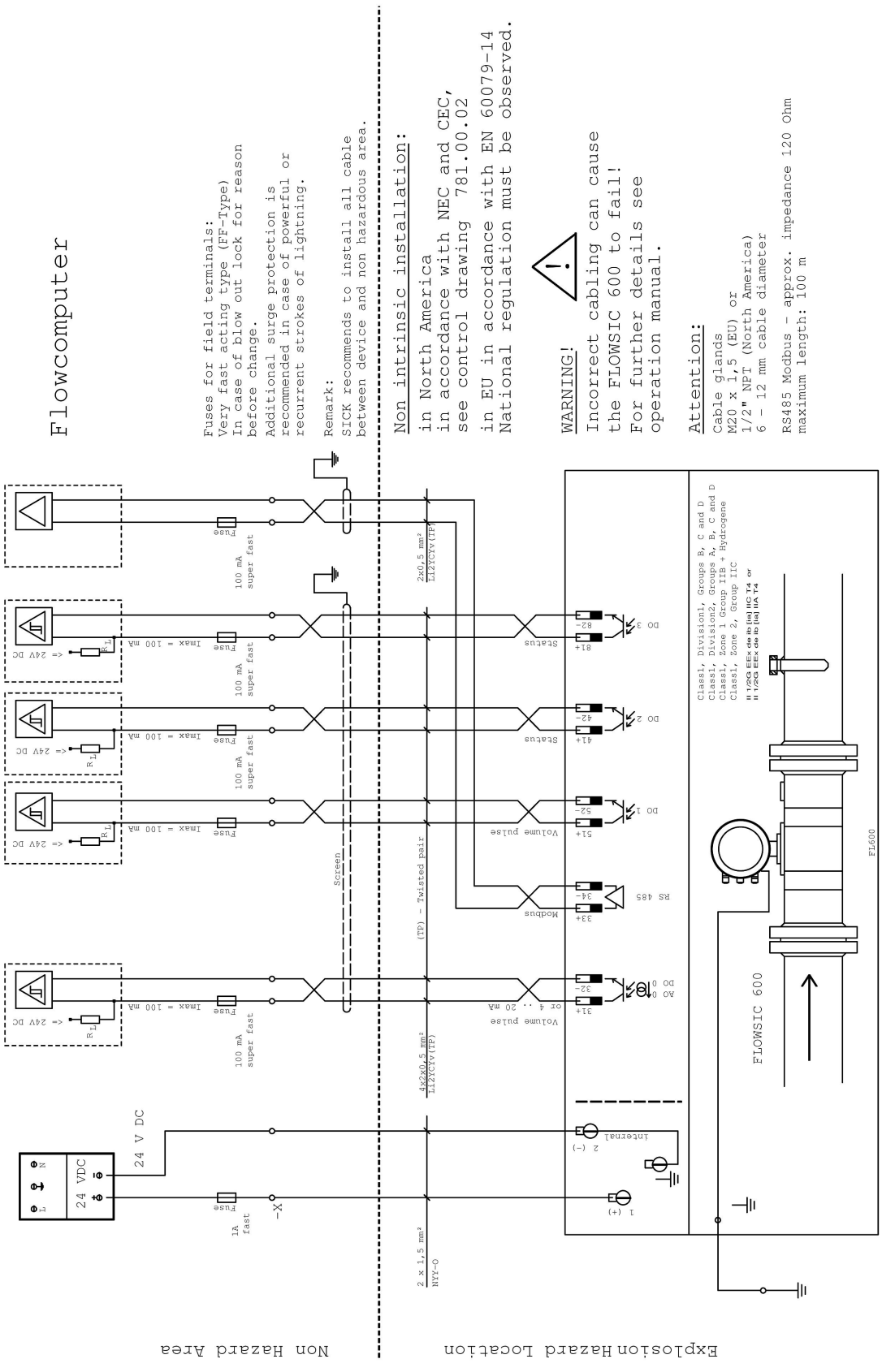


Fig. 9.20: FLOWSIC600 non-intrinsically safe installation


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## 9.7 Sealing Plan

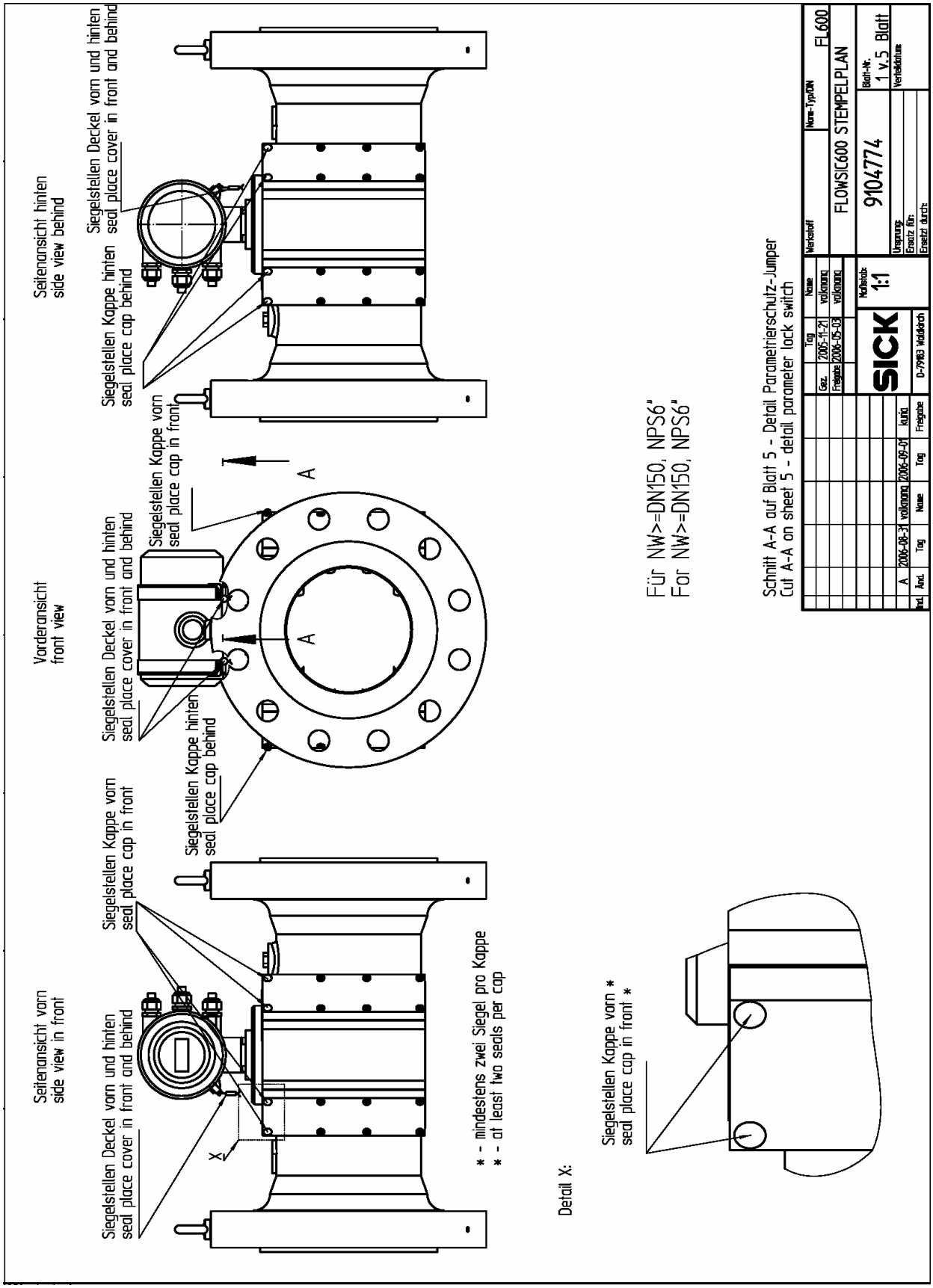


Fig. 9.21: Sealing plan, part 1

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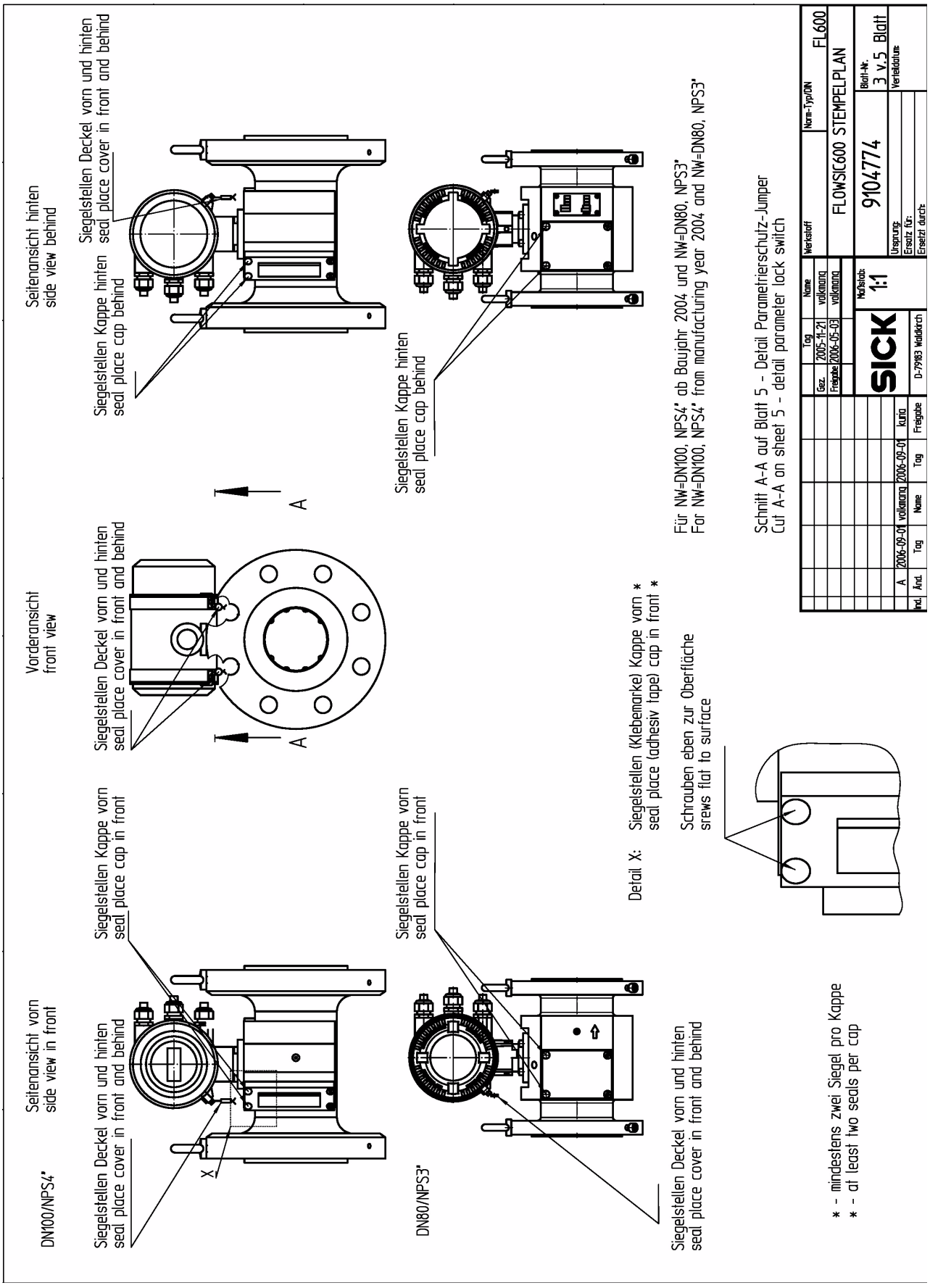
Seitenansicht hinten
side view behind
Siegelstellen Deckel vorn und hinten
seal place cover in front and behind
Siegelstellen Kappe hinten
seal place cap behind
Vorderansicht
front view
Siegelstellen Deckel vorn und hinten
seal place cover in front and behind
Siegelstellen Kappe hinten
seal place cap behind
Für NW=DN100, NPS4" ab Baujahr 2004 und NW=DN80, NPS3"
For NW=DN100, NPS4" from manufacturing year 2004 and NW=DN80, NPS3"
Schnitt A-A auf Blatt 5 - Detail Parametrierschutz-Jumper
Cut A-A on sheet 5 - detail parameter lock switch
Seitenansicht vorn
side view in front
DN100/NPS4"
Siegelstellen Deckel vorn und hinten
seal place cover in front and behind
Siegelstellen Kappe vorn
seal place cap in front
DN80/NPS3"
Siegelstellen Deckel vorn und hinten
seal place cover in front and behind
Siegelstellen Kappe vorn
seal place cap in front
Detail X: Siegelstellen (Klebemarke) Kappe vorn *
seal place (adhesive tape) cap in front *
Schrauben eben zur Oberfläche
srews flat to surface
* - mindestens zwei Siegel pro Kappe
* - at least two seals per cap
SICK
FLOWSIC600 STEMPELPLAN
9104774
FL600
3 v.5 Blatt

Fig. 9.22: Sealing plan, part 2


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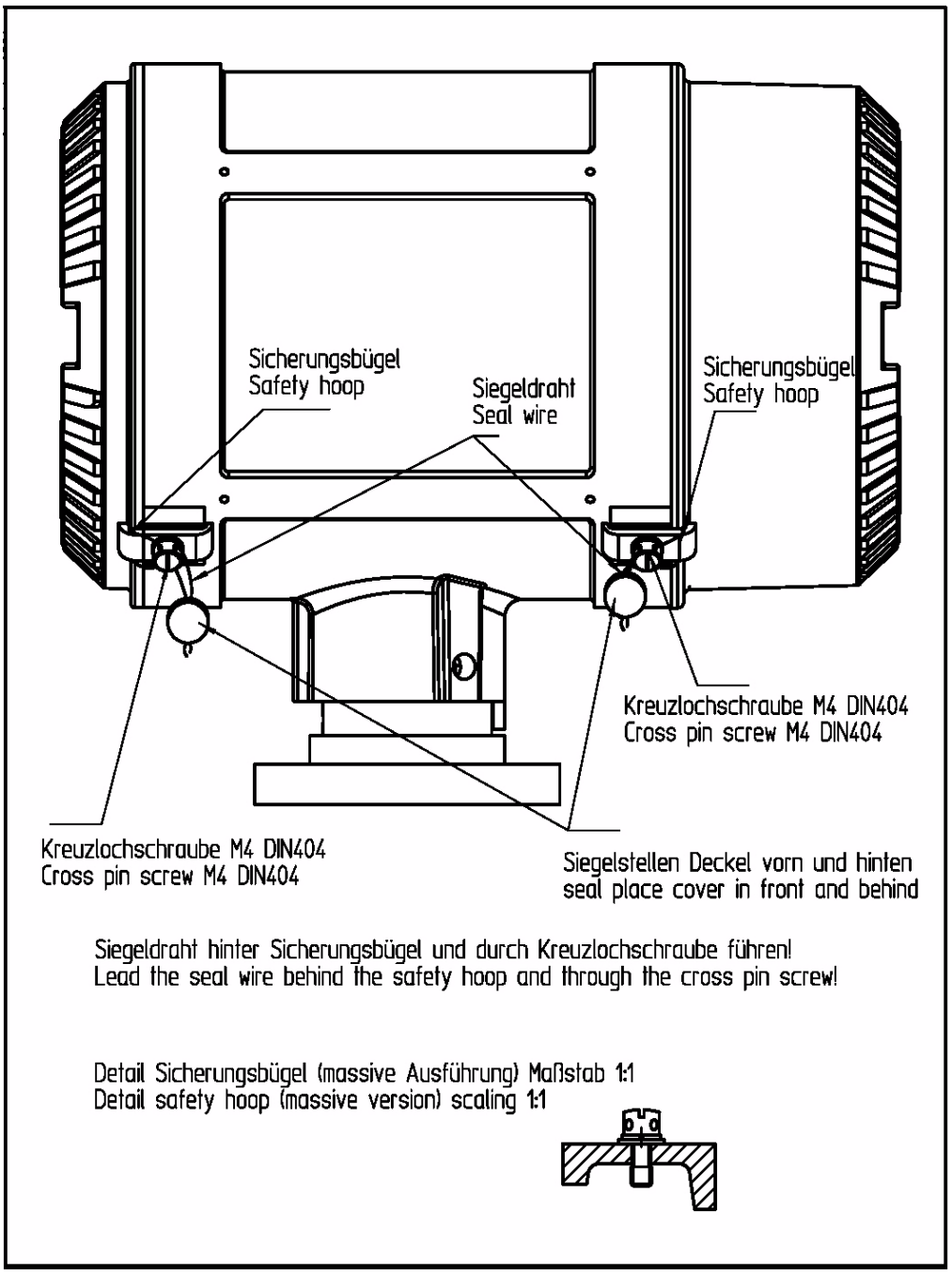
Sicherungsbügel
Safety hoop
Siegeldraht
Seal wire
Sicherungsbügel
Safety hoop
Kreuzlochschraube M4 DIN404
Cross pin screw M4 DIN404
Kreuzlochschraube M4 DIN404
Cross pin screw M4 DIN404
Siegelstellen Deckel vorn und hinten
seal place cover in front and behind
Siegeldraht hinter Sicherungsbügel und durch Kreuzlochschraube führen!
Lead the seal wire behind the safety hoop and through the cross pin screw!
Detail Sicherungsbügel (massive Ausführung) Maßstab 1:1
Detail safety hoop (massive version) scaling 1:1

Fig. 9.23: Sealing plan, part 3

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